DIPAC TECHNICAL REVIEW COMMITTEE
FINAL REPORT

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Prepared by
The DIPAC Technical Review Committee
For
The Alaska Department of Fish and Game
and
Douglas Island Pink and Chum, Inc.

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This report was prepared by the Douglas Island Pink and Chum (DIPAC) Technical Review Committee, which had the following membership:

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Dr. Don Amend from the Southern Southeast Regional Aquaculture Association (SSRAA)

Steve McGee acted as chairman of the technical committee and compiled material from committee members for the report. The technical committee held three meetings to discuss the issues of concern and to review draft documents.

EXECUTIVE SUMMARY

The DIPAC Technical Review Committee was established to examine fish cultural and commercial fisheries data to determine, if possible, why DIPAC's pink salmon did not return, as expected, to the Sheep Creek special harvest area in 1989. Less than one-tenth of the anticipated number of pink salmon arrived back at the hatchery. The hatchery return was 66,000 fish, which represented 0.16% total marine survival to the terminal harvest area.

Hatchery incubation and rearing procedures were reviewed by the technical team. In-hatchery survivals have been excellent at DIPAC facilities. Based on data collected by NMFS from Auke Bay, DIPAC released its pink salmon fry later than the optimal time in April. However, there is no indication that release timing is solely responsible for the poor survival experienced in 1989. Predation by hatchery-produced chinook and coho smolts, and by Dolly Varden and herring, was considered as a potential, but unquantified, source of mortality. Predation by chinook and coho smolts does not appear to be a problem at present, but steps should be taken to avoid or reduce potential Dolly Varden and herring predation.

The range in survival for DIPAC pink salmon was 0.16% - 2.16% for the period 1982 through 1989. The 14-fold variation in survival for DIPAC pink salmon is not inconsistent with the range in survival experienced at other hatcheries. In contrast, wild pink salmon stocks have been observed to vary 100-fold in survival.

Management of the pink salmon harvest in the Icy Strait/Upper Chatham Strait area was changed during the mid-1970s to more discrete stock-unit management, whereby early-run stocks were allowed to enter terminal areas to assess their strength before fishing was initiated. The Hawk Inlet area north of Point Marsden is opened when northern inside stocks are determined to have harvestable surpluses. The area south of Point Marsden is managed to harvest surpluses of southbound fish and, later in the season, to harvest local Chatham Strait stocks. The Board of Fisheries authorized the department to open fisheries along the Hawk Inlet Shore north of Point Marsden during July, dependent upon early assessment of Taku River pink salmon and the general abundance of pinks in the Hawk Inlet area. In 1989, that fishery was opened between Hanus Reef and Funter Bay on July 9 resulting in the harvest of 93,000 pink salmon, and between Point Marsden and Funter Bay on July 16 and 17 resulting in harvests of 156,000 and 401,000 pink salmon, respectively. Purse seining continued south of Point Marsden in July and August. The fishery north of Point Marsden was opened to the latitude of Hanus Reef for nine hours on August 1; no further fishing occurred in the area thereafter.

An analysis of estimated DIPAC hatchery contribution to the Icy Strait/Upper Chatham pink salmon fishery suggested that between 14,500 and 43,800 of DIPAC's pink salmon were harvested in 1989. The maximum harvest rate for these estimates was 34.8%. Total marine survival corresponding to this harvest would have been 0.3%. If DIPAC fish had survived at 2.0% in 1989, the harvest rate would have been in excess of 90%. The technical team felt this was unlikely considering the magnitude of natural stocks in the area, the fishery's distance from the hatchery, and the amount of the migratory area closed to fishing.

Analysis of run-timing and sex ratios in the terminal harvest of DIPAC fish indicate DIPAC pink salmon would have been in the Hawk Inlet and Point Augusta areas in late June and early July and would have been intercepted, along with other stocks, in the fisheries conducted there. The run-timing of DIPAC pink salmon appeared to be approximately the same as that for previous odd-year returns. Comparison of the

relative strength of the 1985 versus 1989 return, based on catch-per-unit-of-effort and cumulative harvest, indicates that, up to July 15, the return in 1989 was only 3%-7% of the 1985 return.

Recommendations of the technical team include: systematic development of means to evaluate changes in hatchery practices such as earlier releases of pink salmon fry; remote rearing and release, new brood stocks; marking of hatchery pink salmon fry to evaluate their contribution to the fisheries; and modification of management practices in upper Chatham Strait fisheries to improve escapement to both wild and hatchery systems in years of poor survival.

INTRODUCTION

Douglas Island Pink and Chum, Inc. (DIPAC) did not have sufficient pink salmon returns to its facilities in 1989 to meet broodstock and cost recovery goals. While it is too late to do anything about the 1989 season, it is necessary to understand what happened in order to attempt to avoid the same problem in the future. The task of the Technical Review Committee was to attempt to identify what happened to DIPAC's fish in 1989 and to provide DIPAC with technical assistance for the future. The review conducted by the DIPAC Technical Review Committee considered the following:

1. Review of fish cultural data on pink salmon from DIPAC's facilities to determine if improvements can be made in hatchery practices to increase the survival and subsequent return of pink salmon.

2. Examination of data from commercial fisheries to determine the extent and magnitude of DIPAC hatchery contributions to fisheries, especially in the Icy Strait/Upper Chatham Strait area.

3. Identification of possible solutions to the problem of insufficient returns to the hatchery, including any need for additional data.

The review followed a general outline suggested by the FRED and Commercial Fisheries Divisions, beginning with a discussion of the fish cultural parameters that may impact survival of hatchery-produced fish and ending with an evaluation of commercial fisheries information. The remainder of the report deals with conclusions reached from the evaluation and with recommendations for the future.

FISH CULTURE

Production Goals for DIPAC Facilities

Sheep Creek Hatchery

The current goal for Sheep Creek Hatchery is 30,000,000 chum salmon fry for release at the Sheep Creek salt water rearing site. In past years, the majority of pink salmon production from DIPAC's facilities (Sheep Creek and Kowee Creek) was released at the Sheep Creek site. With the Gastineau Channel Hatchery now on line, incubation of pink salmon eggs at Sheep Creek Hatchery will cease. However, pink salmon from the Gastineau Hatchery will be released from the Sheep Creek salt water net-pen site.

Gastineau Channel Hatchery

Permitted production at the Gastineau Channel facility includes 50,000,000 pink salmon fry along with 111,000,000 chum salmon, 1,000,000 coho salmon and 200,000,000 chinook salmon. DIPAC currently plans to release 40,000,000 pink salmon fry from the Sheep Creek site for cost recovery/brood stock purposes and 10,000,000 from the Gastineau Channel site for brood stock. However, it is possible that DIPAC will begin to explore alternative cost recovery/terminal harvest sites for pink salmon in order to improve survival. DIPAC plans to release only 11,000,000 of the 111,000,000 chum salmon fry at the hatchery site. The remainder will be released from remote rearing sites in Lynn Canal, either for cost recovery (40,000,000 at Amalga Harbor), or terminal harvest by common property user groups (60,000,000 at sites in Lynn Canal). Incubation of salmon at Gastineau Hatchery was initiated in 1989. Broodstock development is still under way for chum and chinook salmon; pink and coho production is already near capacity, assuming sufficient returns from previous releases.

Kowee Creek Hatchery

The Kowee Creek facility was originally permitted for up to 10,000,000 pink and/or chum salmon fry. However, with the construction of the Gastineau Channel facility, DIPAC changed the mission at Kowee Creek Hatchery to the production of steelhead trout. Until the trout program begins, DIPAC is permitted to use the facility for chum production to be released at the Sheep Creek salt water site.

Historical Production Performance

For purposes of this review, only the production of pink salmon was examined. A summary of pink salmon production from the Sheep Creek release site is detailed below.

Brood Year	Ponding Date	Number Released (Millions)	Fed/ Unfed	Size (g)	Release Date	Calendar Year	Return to Hatchery (Thousands) Hatchery	Percent Return to Date	Commercial Fishery Opening (Thousands)	Commercial Harvest in 114-27/112-16
1980		1.14	UF			1982	6.0	0.53	8/1	3,700.0
1981		9.00	UF			1983	80.0	0.89	7/24	900.0
1982		14.49	UF			1984	53.0	0.37	7/22	770.0
1983		32.01	UF			1985	429.1	1.34	7/18	4,000.0
1984		14.94	UF			1986	19.7	0.13	8/7	150.0
1985	4/4-	26.50	F	0.33	5/9	1987	770.0	2.16	7/12	1,700.0
	4/25	9.20	F	0.46	5/21					
1986		8.40	F			1988	20.5	0.24	8/7	40.0
1987	3/21-	14.90	F	0.39	5/10	1989	66.6	0.16	7/9	3,100.0
	4/18	14.90	F	0.40	5/14					
1988		15.00	F							

Water Temperature Profiles

Historic water temperature data for incubation and freshwater rearing are available for DIPAC's facilities. However, beginning in 1985, all pink and chum fry have been held in salt water net pens for rearing prior to release, hence the temperature of the fresh water is no longer a critical factor. Salt water temperatures and release timing for 1986-1988 are shown in Figures 1-3.

Incubation and Rearing Procedures

Pink and Chum eggs at DIPAC hatcheries are incubated in Zenger boxes, stacked five high with 10-15 gpm water flow. Pink eggs are loaded at 300,000 eggs per tray and chum at 180,000 to 190,000 eggs per tray. Outmigration is volitional, sometimes enhanced by opening incubators so that light may enter. Fry are enumerated by displacement of water in the transport tank. One inch of displacement is equal to 200,000 fry. This relationship was established by actual counts of fry into the tank. Survival of eggs to the eyed-stage has averaged over 95% per year. Survival from green egg to emergence has averaged over 93% per year.

The salt water pens used are 40'x 40'x 10', arranged in tandem and made of 1/8-inch mesh net. Density of pink salmon in the pens has been as high as 5,000,000 fry per pen but was reduced from that level because of experience in 1987 that showed signs of overcrowding. Chums have been held at 2,800,000-3,000,000 fry per pen. Mortality in the pens has not been accurately determined because only dead fish that float to the surface have been enumerated. No count of mortalities on the bottom of the pens has been attempted. Even though accurate counts of mortalities have not been made, no indication of unusual mortality have ever been observed.

Release Timing

DIPAC has determined release timing for pink salmon mainly by size of fish achieved before the end of May. Based on the natural migration timing of pink salmon, it is probable that pinks have been released at Sheep Creek somewhat later than the optimal time. According to information from studies conducted by NMFS in Auke Bay, size does not seem to be as important as timing in determination of release strategies for pink salmon. Net-pen reared pink fry go through a near-shore rearing phase before migrating out of Auke Bay. The duration of the near-shore rearing phase for pen-reared fry is shorter than that for fry released directly from freshwater.

In Auke Bay, pink salmon fry generally achieve a size sufficient to move out of the near-shore area by the third week in May to the first week in June. Pink salmon grew faster in Auke Bay in 1988 than in prior years and, because they achieved a larger size earlier, may have left the bay at an earlier date than usual. Survival to adult of wild Auke Creek pink salmon was lower in 1989 (4.3%) than in 1987 (10.0%) or 1988 (27.0%), based on data collected at the Auke Creek Weir. The relatively low survival in 1989 may be related to the unusually early migration of fry out of the bay.

There is no indication that release timing was solely responsible for the poor adult return experienced by DIPAC in 1989 (1987 brood-year fish). Information from the NMFS Auke Bay Lab indicates the best time for release of pink salmon is mid-April. Releases of DIPAC pink salmon fry, beginning about the 15th of April and continuing until about the 20th of May, would allow an experimental evaluation of the impact of early versus late release timing on survival of that hatchery's pink salmon.

DIPAC's goal is to triple the size of pink salmon and double the size of chums before release. Based on past experience, this goal is probably optimistic for pink salmon since it has never been achieved. No method to correlate releases with plankton abundance is being used.

The seasonal rise in water temperature to the 5-6° C level may be an important indicator of an impending increase in productivity. Dividing the release into increments of approximately 1/3 on successive dates may be a way to mitigate unknown, but presumably adverse, survival conditions since optimal release timing cannot be precisely determined in advance. Salt water temperatures in both Auke Bay and at Sheep Creek, release dates, and timing of phytoplankton blooms in Auke Bay for 1986-1988 are included in Figures 1-3. In general, pink salmon have been released at DIPAC's Sheep Creek site at least one month after the onset of the plankton bloom in Auke Bay and well after water temperatures have passed the 6° C level.

The impact of predation by concurrently released coho salmon smolts or by natural populations of Dolly Varden or herring on hatchery pink salmon fry was considered as a possible explanation for the poor return of fish in 1989. Past experience at SSRAA facilities in Neets Bay is inconclusive as to the impact of coho smolts on survival of wild and hatchery-produced pink and chum salmon. However, SSRAA routinely allows 2 - 3 days between releases of its chum and coho salmon in an attempt to allow the fry to disseminate before smolt are released. Studies by the department on releases of hatchery-produced chinook salmon have not shown an impact on wild pink and chum fry. During the spring of 1988, chinook and coho salmon were released in the Juneau area on the following dates:

Chinook: Montana Creek - 52,000 on May 16
Auke Creek - 92,000 on June 5
Fish Creek - 74,000 on June 5
Sheep Creek - 31,556 on June 5

Coho: Dredge Lake - 50,000 on May 16
Fish Creek - 50,000 on June 5
Sheep Creek - 100,000 on June 5
Auke Rec. - 18,900 on June 5
Gastineau - 49,700 on June 5

Since virtually all smolt releases in 1988 occurred more than one month after the release of the 1987 brood of pink salmon, predation by hatchery-produced smolts was not likely a problem. However, for the future, DIPAC should consider the possible impact of predation by its own coho production on releases of pink and chum salmon in the immediate Gastineau Channel area, especially when releases of coho smolt approach 1,000,000 fish. A delay of several days between releases of pink fry and coho smolt should give fry an opportunity to disburse and acclimate to their new environment.

Predation by herring and Dolly Varden may have a greater impact on released fish than that caused by coho smolts released at locations in the Juneau area. There is some evidence that a growing population of herring exists south of Sheep Creek. Preliminary data from the NMFS Auke Bay Recruitment Study on pink salmon suggest that predation by Dolly Varden is significant but for a restricted period of time. Based on the data from Auke Creek, out-migration of Dolly Varden increases during the last week in April and peaks during the first two weeks of May. Presuming predation by Dolly Varden on pink salmon is greatest during this time period, it may be appropriate for DIPAC to time its releases to avoid periods of peak Dolly Varden abundance. Releasing the hatchery-produced pink and chum fry at night may also be a precautionary measure DIPAC will want to pursue in the future. However, daytime releases did not seem to be a problem in the past as the largest return ever to DIPAC's facilities came from the 1985 brood-year (released in 1986 and returned in 1987) when half to three quarters of the fish were released during mid-day. Higher concentrations of herring may have been present in 1987 and 1988.

Feeding Program

DIPAC has used Biodiet products for all of its feeding programs. Food is stored in a dry van with no apparent over-heating problems in the spring, and it is always fed before the expiration date. Feeding rates are determined using the feed chart supplied by the manufacturer and marine water temperature at the time of feeding. Generally, rates have been 2%-3% of body weight per day. Initial feeding at the time of ponding in salt water has occurred every half hour beginning at 7:30-8:00 am and ending at 5:00-5:30 pm. This schedule results in approximately 20 feedings per day. It has been the experience of NSRAA that feeding more than 4-5 times per day may contribute to "pinheading" of fry as a segment of the population never seems to get to the food. Also, NSRAA has found broadcasting of feed, especially getting it away from the immediate area of the feeder, to be important as the fish tend to avoid the area immediately adjacent to the feeder. Feed conversion ratios of 1.6:1 and 1.8:1 were achieved at Gastineau and Sheep

Creek Hatcheries in the spring of 1988 with 1987 brood year fish. Such ratios indicate nothing out of the ordinary in the feeding program.

Disease History

DIPAC has never experienced a diagnosed disease problem in its pink or chum salmon at any of its facilities. Vibriosis was suspected in brood year 1985 because of the slightly elevated mortality in salt water prior to release but none was found.

Water Quality

No record of total dissolved gas exists for DIPAC facilities; therefore, it is not possible to determine whether a chronic problem with gas supersaturation exists. It was recommended that DIPAC obtain a saturometer to routinely measure total gas pressure in the water at each of its facilities. Other operators indicated this is a standard procedure at their facilities.

Water quality testing at the time of permitting indicated nothing unusual at any of DIPAC's facilities. Ongoing water quality testing at the Sheep Creek site began in July 1989 in response to mine development in the Sheep Creek valley.

Variation in Survival

The data presented in the historic production table on p. 3 show a range in survival of 0.16% to 2.16% for odd-year returns, as measured by return to the terminal area. This range represents a 14-fold difference in survival. Other hatchery operators have experienced 10 to 15-fold variations in survival with pink and chum salmon. Wild stocks exhibit variations of 100-fold (e.g., Auke and Sashin Creeks). The question was raised as to whether the survival experienced by DIPAC's pink salmon in 1989 (0.16%) was less than might be expected. The majority of experience with pink salmon in Alaskan hatcheries has been at facilities located in Prince William Sound, Cook Inlet, and Kodiak, which do not necessarily reflect survival conditions in Southeast Alaska. Only one other facility in Southeast Alaska (Burnett Inlet) has had a sufficient number of returns to establish a track record. Returns to Burnett Inlet Hatchery have varied from 0.75% to 4.73% since 1982. This variation represents a 6-fold difference in survival over a period of time comparable to that for DIPAC's returns.

EVALUATION OF FISHERIES INFORMATION

History of the Icy Strait/Chatham Strait Fishery

Many fish traps were located in Icy Straits and Chatham Straits prior to Alaska statehood in 1959. The five floating traps that operated between Hawk Inlet and Funter Bay were located at sites that produced high catches. After statehood, fish traps were banned and purse seine gear was utilized to harvest the pink salmon returns. In the 1960s, the seine season started in outer Icy Straits in early July and as the season progressed the fishing fleet dispersed to the inside and southern districts. The early season fishery (early July) harvested many pink salmon stocks, and weak stocks could not be detected until after excessive harvest had already occurred. Early runs to Seymour Canal and Frederick Sound began to experience poor returns in the late 1960s and early 1970s because of over-harvesting in mixed stock fisheries. Management of the pink salmon harvest was changed during the mid-1970s to more discrete stock management whereby the early runs were allowed to enter terminal areas in order to assess their strengths and determine harvest levels. This management continues today with fishing in Icy Strait limited to areas that target on local stocks. Stocks that are now managed separately early in the season are those returning to Tenakee Inlet, Peril Strait, Frederick Sound and Seymour Canal. In Chatham Strait, fishing is delayed until indications of abundance are determined in the inside areas. The Hawk Inlet Shore north of Point Marsden is opened when northern inside stocks are determined to have harvestable surpluses. The area south of Point Marsden is managed to harvest surpluses of southbound fish and, later in the season, to harvest local Chatham Strait stocks. Tables 1 and 2 show the historical purse seine harvest of all salmon since 1960 in Icy Strait, District 14, and Chatham Strait, District 12. Tables 3 and 4 show the historical purse seine harvest in the Hawk Inlet Shore area (Subdistrict 112-16) and the Whitestone Shore area (Subdistrict 114-27).

Recent Board of Fisheries Regulatory Changes

Prior to 1984, fisheries managers were under no regulatory limitation in determining when to open the Hawk Inlet Shore. An unwritten policy from the Board of Fisheries, however, was instituted in the early 1980s whereby the northern boundary of the purse seine fishery in that area was at the latitude of Hanus Reef Light. During the 1960s and 1970s no guidelines were established for allocation of fish between drift gillnet and purse seine gear types as was done in the 1980s. Since 1984, by Board of Fisheries action, the Hawk Inlet Shore was closed to salmon purse seining north of Point Marsden until August 1. Prior to 1984, the area was usually opened in late July, depending upon the pink salmon run strength. Table 5 shows the opening dates and the northern boundary of the Hawk Inlet Shore since 1967.

The controversy over purse seine fishing in the Hawk Inlet Shore has arisen largely due to a general increase in the abundance of pink salmon in the area. Recent information suggested that a large pink salmon stock was being underutilized. Village Falls on the Nakina River, a Canadian tributary of the Taku River, was blasted-out in 1977 to improve chinook salmon passage over this partial barrier. This stream enhancement project also opened several miles of additional spawning area to pink salmon. Pink salmon returns to the Taku River increased dramatically as evidenced by catches at the Canyon Island fish wheel site. The odd-year return to the Taku River in recent years has exceeded the interim escapement goal of 250,000 to 300,000 fish established by the Transboundary Technical Committee of the U.S./Canada Pacific Salmon Commission. The 1985 and 1987 escapements were estimated by mark/recapture ratios to be approximately 1,000,000 fish each year.

During the fall of 1983, the Board of Fisheries considered a proposal to allow an experimental pink salmon fishery in the District 11 Taku Inlet gillnet area to utilize the harvestable surplus of pink salmon returning to the Taku River. An experimental gillnet fishery limited to 5-inch maximum mesh size was established for the 1984 season. At this same meeting a regulation was adopted whereby purse seining could not occur north of Point Marsden until August 1.

After conducting the experimental gillnet fishery during 1984 and 1985, department staff presented the results to the Board of Fisheries during the winter of 1985. More pink salmon were caught per boat during the special fishery, but the pink harvest overall was smaller than during the regular sockeye fishery opening because of low participation in the new fishery. Sockeye catches per boat were also very high in this special 5-inch maximum mesh size fishery. It was concluded that additional fishing time to harvest pink salmon with small mesh gillnets would over-harvest sockeye if the normal fishing periods for sockeye were maintained in addition to the time allowed for the pink salmon fishery. Changing the fishery to target on pink salmon would not be practical since it would probably result in drop outs of the larger more valuable sockeye. The special, mesh-size restriction fishery was not continued after 1985.

During the fall of 1988, the Board of Fisheries was again faced with proposals dealing with the utilization of the Taku River pink salmon stock. Gillnet fisherman proposed another special fishery with a smaller mesh size of 4 3/4 inches to better harvest the pinks. Purse seine fisherman proposed allowing a seine fishery north of Point Marsden during July. With the results of the 1984 and 1985 experimental gillnet fishery, the Board provided fisheries managers with the option in 1989 to open the Hawk Inlet Shore to purse seining north of Point Marsden during July. The opening would be dependent upon the early assessment of Taku River pink salmon and the general abundance of pinks in the Hawk Inlet area. Conservation of all species was to be considered prior to opening the area, and a maximum harvest of 15,000 sockeye was established for the area during July. The results of the new fishery would be evaluated by the board during its winter 1990 meeting.

Management of the Hawk Inlet Shoreline in 1989

Prior to the 1989 summer season, both drift gillnet and purse seine fishermen were concerned about how the department was going to manage this new fishery. Gillnet fisherman were concerned that an over-harvest of sockeye from systems with poor returns would occur and that the poor Snettisham Hatchery chum returns would also be impacted. Both gear groups were also very concerned about how the department would manage the 15,000 sockeye quota.

A Hawk Inlet Shore test fishery was established to give fisheries managers some insight as to the abundance of pink and sockeye salmon at several sites prior to an opening. Additional monitoring effort by the staff was also planned during the fishery to determine the composition of sockeye in the catch and to document each boat that participated in the fishery.

The 1989 Southeast Alaska purse seine fishing season began on July 2 in limited areas. The first opening along the Hawk Inlet Shore was on July 9. The following information was reviewed prior to the July 7 opening announcement:

Gillnet fishery Dist.11

Stat. Week	Pink Catch	% of Ave.(odd yrs 71-87)
25	122	64%
26	2,786	169%
27	26,445	226%

Canyon Island Fish Wheel

Year	Cumulative Catch through 7/6	Annual Total Catch	Annual Escapement Estimate
1985	2,310	27,670	1,051,871
1987	3,316	42,786	740,727
1989	3,507		

Test Fishing Results

Date	No.Sets	Set Location	Sockeye	Coho	Pink	Chum
6/29	1	Lizard Head	58	0	389	81
	1	S. Funter	62	0	244	21
	1	N. Funter	23	0	122	41
	1	False Retreat	123	3	152	13
7/6	1	Lizard Head	28	1	241	47
	1	S. Funter	5	3	159	39
	1	N. Funter	73	0	665	29
	1	False Retreat	96	2	666	47

Aerial Survey

7/5	Seymour - no show yet Tenakee some showing Hawk Inlet Shore - 9 pink, 5 chum or sockeye jumps. S. Funter 4 pink, 2 chum or sockeye jumps. N. Funter

The Taku Inlet gillnet fishery was experiencing exceptionally good pink salmon catches as was the Canyon Island fish wheel. The catches were comparable to 1985 and 1987. Although the test fishing and aerial surveys did not reveal a large abundance of pinks, the gillnet fishing success and catches at the fish wheel did. Therefore, an opening of the new Hawk Inlet Shoreline fishery on July 9 was considered appropriate.

Considering the good sockeye catches in the test fishery north of Funter Bay, and not knowing how many boats would participate in the fishery, a limited opening was announced. The fishery objective was to harvest early-run pinks over several weeks rather than catching the sockeye quota in one opening, which might have occurred by fishing north of Funter Bay. The Hawk Inlet Shore south of Funter Bay and north of the latitude of Hanus Reef light within two nautical miles of the Admiralty Island shore (shown in Figure 4) was open for 11 hours from 9:00 a.m. through 7:00 p.m. on July 9. The two-hour delayed opening and 2-hour earlier closure (than other open areas) was intended to discourage the movement of boats to nearby open areas. As shown in Figure 5, Port Frederick and Tenakee Inlet were also open for a normal 15-hour period from 6 a.m. to 9 p.m., along with areas in Districts 1, 2, 4, 10 and 13.

Prior to the fishery, all 62 vessels that participated were registered by department staff. Effort was spread all along the shoreline from the northern line at the southern entrance to Funter Bay to the southern line at Point Marsden. No vessels entered the fishery after the opening, or left the area prior to the closure. The weather was calm and sunny. The fishery was not as good as expected, with an estimated catch at

the end of the day of 50 sockeye and 1,500 pinks per boat, and a total estimated catch of 3,100 sockeye and 93,000 pinks.

On July 13 another opening was announced for July 16 in the same area north of Point Marsden to Funter Bay. The area was expanded southward from the latitude of Hanus Reef to Point Marsden to harvest additional southbound stocks which were beginning to show well in areas with early runs. A standard 1-day, 15-hour opening was scheduled with notice of a possible extension. Information considered prior to the announcement was another week of District 11 gillnet pink salmon catches, catches of pinks at the Canyon Island fish wheel, purse seine test fishing results, and aerial escapement surveys.

The information reviewed prior to the second opening announcement is shown below.

District 11 Gillnet

Stat. week	Pink Catch	% of Ave.(odd yrs. 71-87)
28	52,643	196%

Canyon Island Fish Wheel

Year	Cumulative Catch through 7/12	Annual Total Catch	Annual Escapement Estimate
1985	3241	27,670	1,051,871
1987	11388	42,786	740,727
1989	6236		

Test Fishing Results

Date	Set Location	Sockeye	Coho	Pink	Chum
7/13	Lizard Head	45	7	2,386	42
	S. Funter Bay	43	3	349	13
	N. Funter Bay	53	3	84	5
	False Pt. Retreat	52	0	293	15

Estimated Catch of Commercial Opening 7/9

62 boats	3,500	500	110,000	5,300

Aerial Surveys

7/10-12 Fish just beginning to arrive in most terminal areas and stream mouths. Abundances appear good.

During the July 16 opening several staff members and guests helped sample the catches aboard seine vessels. By early afternoon, it was estimated that each boat would average approximately 100 sockeye and 5,000 pinks for the day. With 45 boats fishing, the catch for the day was estimated at 4,500 sockeye and 225,000 pinks. The total sockeye catch through July 16 was approximately 8,000 fish. With 7,000 sockeye left in the area's quota, and the fishery experiencing excellent pink salmon catches, the fishing period was extended 24 hours to 9:00 p.m. Monday, July 17.

During the second day of fishing, effort shifted more to the southern portion of the open area where catches were better. Sampling aboard fishing vessels continued, although with less intensity than the day before. Fishing success on both sockeye and pinks appeared to be about the same as the day before. After the fishing period it appeared the fishery was very close to a total catch of 12,500 sockeye. Another opening could not be scheduled without exceeding the 15,000 sockeye quota. No further openings occurred north of Point Marsden until August 1 when one day was allowed from 12:01 a.m. through 9:00 p.m.

Some movement of boats was documented to and from the Hawk Inlet fishing area during the second fishing period. Of the 45 boats that fished the area, 4 boats left after the first day, 2 other boats left and returned later during the period, and 3 boats fished only the second day.

Purse seining continued south of Point Marsden in July and August and exceptionally large pink salmon catches were taken. Fishing did not occur again north of Point Marsden until August 1 when the area was opened to the latitude of Hanus Reef for 9 hours at the end of an ongoing fishing period which was open from Pt. Marsden to Pt. Hepburn. No fishing occurred after August 1 because of an observed weakness of pink salmon escapement in Lynn Canal and upper Stephens Passage. The 1989 preliminary total catch for the July fishery north of Pt. Marsden was approximately 15,000 sockeye, 671,000 pink, 19,000 chum, and 1,200 coho.

Fishing was conducted in Subdistrict 112-16 from Point Marsden south to Point Hepburn on July 20, 23, 24, 27, 28, 30, and Aug.1, 4, 5, 6, 9, 10, 11, 14, 15, 16, 17, 20, 21, 22, 27, 28, 29, and 30, for a total of 24 days. The preliminary weekly catch data are shown in Table 6. The daily harvest in subdistricts 114-27 and 112-16, and in the DIPAC hatchery Special Harvest Area for the month of July during the last three odd years (1985, 1987 and 1989) is shown in Table 7. Total annual catch and effort for subdistrict 112-16 from 1982 to 1989 is shown in Table 8.

Daily catches of pink salmon at the Canyon Island fish wheel for 1989 are shown in Figure 6 along with average daily odd-year catches. Peak catches normally occur around July 15 in odd years and 1989 was no exception.

Harvest of Local Hatchery Stocks in the Hawk Inlet Fishery

The implementation of the Hawk Inlet fishery in 1989 caused concern about its impact on returns to the State of Alaska hatchery in Port Snettisham and the DIPAC hatcheries. Unfortunately, the 1989 Snettisham chum salmon return was extremely poor, and no tags were recovered in the seine fishery. DIPAC pink and chum salmon returns were not tagged, so no harvest data are available for them. Table 9 shows the recent chum salmon returns to Snettisham Hatchery and their harvest rates based on tag recoveries.

Good information is available on the total abundance of sockeye passing through the Hawk Inlet Shore fishing area. This information permits computation of the harvest rate experienced by migrating sockeye stocks while in the Hawk Inlet Shore area. Table 10 shows the approximate harvest rate on sockeye in Subdistrict 112-16 by purse seine gear to be approximately 4%.

Comparison of Harvest Management Strategies

Graphic presentations of fishery openings and effort, numbers of pink salmon harvested, and area opened/fished in the Icy Strait/Upper Chatham Strait area for the last three odd-year returns are shown in Figures 7, 8 and 9. The 1989 fishery appears to have been similar to the 1985 fishery with respect to the amount of time and area fished. Effort levels were higher in 1985 than in 1989 with the exception of the 3-day fishery in July along the Hawk Inlet Shore that harvested 650,000 pink salmon north of Point Marsden. The harvest of pink salmon for each of the last three odd-year returns (1985-1989) is presented by calendar week in July for Subdistricts 114-27 and 112-16, and for the Sheep Creek special harvest area, in Figure 10. One of the most obvious differences among the three years for Subdistrict 112-16 is the larger catch during the third weekly opening. That harvest is represented by the 3-day fishery north of Point Marsden.

Analysis of Marine Survival and Harvest Rates

Harvest rates for returning stocks of pink salmon can be estimated in a gross way by making assumptions about the total abundance of pink salmon passing through the fishing area, based on assumed migration paths and expansions of escapement. The underlying assumption used in making this estimate is that the harvest rate for wild stock pinks must be equal to the harvest rate for the hatchery stocks passing through the same fishing area. The technique results in a rather rough estimate of the hatchery contribution since the estimate of the total number of pinks in the intercept area is crude. The estimate of the number of pinks in the intercept area could be biased upward because it is based partially on the number of pinks caught in, or escaping to, other areas, and these fish were not necessarily present in the intercept area at the time of the fishery. The estimated harvest rate could also be biased downward because indices of escapement are usually low estimates of actual escapement. Also, the technique includes pinks from the entire season not just pinks with run timing similar to DIPAC pinks. Nevertheless, this technique should give a realistic range of values if both high and low estimates of the number of pinks in the intercept area are used to determine high and low estimates of hatchery contribution.

The following formula was developed by the Commercial Fisheries Division to estimate the contribution of DIPAC pink salmon to the commercial seine fisheries in Northern Chatham Strait:

Low Range Estimate

$$\text{Est. Hatchery Contribution} = \frac{\text{Hatchery SHA Return}}{\text{Total est. of pinks in Harvest intercept area}} \times \text{Intercept Area}$$

Where: total est. of pinks in intercept area = Harvest in other areas + 4 times the index of escapement

In 1989 the numbers were as follows:

$$\text{Est. Hatchery Contribution} = \frac{82{,}111}{17{,}687{,}000} \times 3{,}120{,}000$$

Where 17,687,000 = 5,687,000 + (4 X 3,000,000)

Est. Hatchery Contribution = 14,500, for a harvest rate of 15%

High Range Estimate

$$\text{Est. Hatchery Contribution} = \frac{\text{Hatchery SHA Return}}{\text{Total est. of pinks in intercept area}} \times \text{Intercept Area Harvest}$$

Where: Total est. of pinks in intercept area = Harvest in other areas / 2 + Index of escapement

$$\text{Est. Hatchery Contribution} = \frac{82{,}111}{5{,}843{,}500} \times 3{,}120{,}000$$

Where: $5{,}843{,}500 = \frac{5{,}687{,}000}{2} + 3{,}000{,}000$

Est. Hatchery Contribution = 43,800, for a harvest rate of 34.8%

When the same technique is applied to hatchery returns in other years, the following results are apparent:

Brood Year	Low Contribution Estimate	Percent Harvest Rate	High Contribution Estimate	Percent Harvest Rate
1980	1,300	17.8%	3,900	39.4%
1981	7,700	8.8%	27,400	25.5%
1982	4,800	8.3%	17,400	24.5%
1983	75,200	14.9%	245,100	36.4%
1984	500	2.5%	2,000	9.2%
1985	89,200	11.3%	313,700	30.9%
1986	200	1.0%	700	3.3%
1987	14,500	15.0%	43,800	34.8%

The low estimate is based on the assumption that all the fish harvested in other areas that escaped the intercept area were susceptible to harvest in the intercept area and that the stream escapement to other areas was four times the escapement index. These assumptions increase the number of fish available in the intercept area and, therefore, decrease the fraction of hatchery fish. The high estimate is based on the assumption that only half of the fish harvested in other areas were susceptible to harvest in the intercept area and that stream escapement to other areas was equal to the escapement index. These assumptions decrease the number of fish available in the intercept area and, thereby, increase the fraction of hatchery fish.

An analysis of possible contribution percentages to the commercial harvest based on a range of hypothetical marine survivals was also conducted for DIPAC pink salmon returns from 1985, 1987 and 1989. The results are presented in Tables 11, 12 and 13, respectively. Using the above high range estimates of harvest rate, the total marine survivals in these years would have been approximately 1.8% for brood year 1983, 2.3% for brood year 1985 and 0.3% for brood year 1987. For a marine survival of 2.0% in 1989 (BY 1987), the harvest rate for DIPAC pink salmon would have been in excess of 90%. Such a harvest rate appears to be extremely improbable.

Run Timing Analysis

In 1977 and 1978, an adult tagging program was conducted on pink salmon in the Hawk Inlet and Point Augusta areas to examine run timing of stocks passing through the Icy Strait/Upper Chatham Strait corridor. Tags recovered from adult pink salmon in Fish Creek as part of that study provide some indication of the timing of this stock in fisheries conducted in the Hawk Inlet and Point Augusta areas. Since Fish Creek was used as the primary source of broodstock for the DIPAC hatcheries, pink salmon

from DIPAC hatcheries should be in the Icy Strait/Upper Chatham Strait area at approximately the same time as the Fish Creek stock. Assuming that run timing of the hatchery fish in 1989 was similar to that in 1977, DIPAC fish would have been in the Hawk Inlet and Point Augusta areas in late June and early July and would have been intercepted to some degree in the fisheries conducted there. The timing of pink salmon returns, in the Hawk Inlet/Point Augusta area, that returned to Fish Creek in 1977 and 1978, is shown in Figures 11 and 12, respectively.

DIPAC has stated that in previous years, particularly 1987, it aggressively harvested the first part of the return to Sheep Creek and then obtained eggs from the later part of the return. In doing so, it hypothesized that it may have changed the run timing to a slightly later return, thereby placing its fish more directly in the fishery. However, it is unlikely that the return could have been altered sufficiently in one generation to result in a 2 to 3-week shift in run timing. Furthermore, some evidence from sex ratios sampled in the terminal harvest suggests the return to the Sheep Creek site in 1989 was slightly earlier than in prior odd years, rather than later, as shown in Figures 13, 14 and 15.

Sex ratio analysis has been found to be useful in determining the run timing of pink salmon in Southeast Alaska and Prince William Sound fisheries. Specifically, PWSAC and DIPAC have used pink salmon sex ratios as an indicator of run timing to help manage their cost recovery harvests in the terminal hatchery areas. It is commonly known that the percent composition of males and females in the pink salmon run changes as the run progresses. Initially the run is predominately males, but the percentage of females steadily increases as the run progresses. Research conducted by ADF&G has shown that at the midpoint of the run, the composition is 50% males and 50% females, assuming that no sex-selective harvesting has occurred (as in the gillnet fisheries). The relative run timing of two stocks or the same stock in different years can be compared by locating the date at which the midpoint of each run (50% males and 50% females) is observed. An analysis of the DIPAC sex ratios from cost recovery harvests in 1985, 1987 and 1989 was performed in order to compare the run timing among years.

A linear regression (weighted by the sample sizes) was performed on the percent females versus the date for DIPAC returns for 1985, 1987 and 1989. The results indicated that the midpoint of the run in 1989 occurred on July 25 (Figure 13), and that the midpoint of the run in 1987 occurred on July 29 (Figure 14). Data were scarce in 1985 and the regression line obtained from them should be viewed with skepticism. No strong comparisons can be made to 1987 and 1989; however, the data points (% females) that do exist for 1985 appear consistent with the data from 1987 and 1989 on the same dates (Figure 15). Hence, there is some indication that the run was slightly earlier in 1989. If the midpoint of the run in 1989 was truly on July 25, and if it takes pink salmon 7 to 10 days to traverse the distance between Hawk Inlet and the hatchery, then a large portion of the DIPAC return could have been present in the Hawk Inlet area at the time of the second Hawk Inlet opening on July 15 and 16.

However, if the cumulative Catch Per Unit Effort (CPUE) in the terminal harvest area up to July 15 is compared between 1987 and 1989, it is apparent that the CPUE in 1989 was much lower than in 1987 (Figure 16). In fact, the cumulative CPUE in 1989 was only 7% of the cumulative CPUE in 1987 on the same date. These fish should not have been impacted by the Hawk Inlet openings on July 9, 15, and 16,

if it truly takes the salmon 7 to 10 days to reach the hatchery from Hawk Inlet. By looking at fish that were not impacted by a commercial fishery, it is possible to get a better estimate of the relative abundance between the two years. The low CPUE in 1989 could be due to the fact that much more effort was expended in 1989 and that additional fishing effort was expended after all the fish were already harvested; this would drive CPUE down. To see if this was the case, the cumulative catches, alone, were compared between 1987 and 1989. Once again it was noted that the catch in 1989 was much lower than in 1987 (Figure 17); the cumulative catch in 1989 was 27% of the cumulative catch in 1987 on the same date.

It is apparent that the cumulative catch and cumulative CPUE of DIPAC's cost recovery harvest in the terminal area up to July 15 were both lower in 1989 than in 1987. The argument could be made that this was due to a shift in the run timing of the stock. In order for the CPUE (assuming CPUE is an accurate reflection of abundance) up to July 15 to decrease in 1989, the run timing would have had to have been later in 1989 than it was in 1987. However, this contradicts the findings of the sex ratio analysis which indicated that the run timing was somewhat earlier in 1989, and seems to indicate that although a large portion of DIPAC's return was potentially present and susceptible to harvest at the July 15 and 16 Hawk Inlet opening, the return itself was not as large as the 1987 return. Comparison of the relative strengths of the 1985 and 1989 returns based on CPUE and catch data presented in Figures 16 and 17 indicate that, up to July 15, the 1989 return was only 3% to 7% of the 1985 return.

CONCLUSIONS

1. In the past, releases of pink salmon fry at Sheep Creek may have been too late to avoid high prey species abundance, and the hatchery fry migration has occurred after the normal migration window utilized by wild pink salmon. However, releases in 1984 and 1986 did result in 1.34% and 2.16% survival and returns to the special harvest area of 429,000 and 770,000 fish, respectively.

2. In eight years of pink salmon returns to Sheep Creek Hatchery (1982 to 1989), the best marine survival to the special harvest area was 2.2%. This survival rate is low considering the extremely high wild stock production during some of those years. During the same time period, Auke Creek pinks demonstrated a much higher marine survival than Sheep Creek pinks. The higher survival at Auke Creek could be due to its location in a more productive area or the result of its late run timing. Gastineau Channel, as a release site for pink salmon, may not be as productive as other sites and, on average, releases there may not result in survivals as high as those in other areas.

3. Sheep Creek hatchery pink salmon certainly contributed to both the purse seine and drift gillnet fisheries during the 1989 season, but to an unknown level. The early July fishing that occurred north of Hawk Inlet no doubt harvested hatchery fish. Pink salmon from DIPAC hatcheries probably contributed to fisheries later in July, as well. However, the probability of the commercial fisheries inflicting a harvest rate high enough to explain the poor hatchery return does not seem reasonable.

If the survival of DIPAC fish in 1989 was similar to that achieved in prior years, the commercial harvest in 1989 would have had to have exceeded 90%, which seems unrealistic considering the probable magnitude of natural stocks in the fishery, the fishery's distance from the hatchery and the amount of the migratory area closed to commercial fishing. The most likely estimate of marine survival for DIPAC pink salmon was 0.3%. Even though the Upper Chatham Strait purse seine fishery was restricted to south of Point Marsden when the northern area wild stock weakness was noticed, escapements in some streams in the Juneau area remained below desired levels. Had management provided for better wild stock escapements, the hatchery return would also have been somewhat better.

4. The 1987 Sheep Creek cost recovery harvest was very intense and very little of the early portion of the return escaped to the hatchery for brood stock. This harvest pattern could have shifted the timing of the 1989 return to a slightly later date since these fish were spawned from the latter portion of the 1987 return. However, a major shift in timing was not evident in 1989.

5. Of the various types of tagging options, a hatchery fry-tagging program would best estimate the number of hatchery fish in the commercial fisheries and help to evaluate the performance of the DIPAC hatcheries. Coded-wire tagging will result in some variance in the estimates of contribution, but it is presently the best technique available. At some time in the future, a better mass-marking technology may be available, but evaluation of the DIPAC hatchery program needs immediate resolution.

RECOMMENDATIONS

1. Develop a program to monitor abundance of near-shore prey species and daily water temperatures. When the water temperature in the near-shore area passes the 4-5 degree C range and continues to rise to 6 or more degrees C, DIPAC should be prepared to release its fish. The spring phytoplankton bloom is another indicator of the onset of productivity that should be monitored. Unless abnormal temperatures exist, releases of hatchery pink fry should begin about mid-April to take full advantage of favorable environmental conditions. In general, the consensus of the committee was that DIPAC should shift the release timing for its pink salmon fry to an earlier time-frame and to test release timing within the period from about the 15th of April to about the 20th of May.

2. Given DIPAC's limited experience in Gastineau Channel, changes in hatchery practices that potentially affect marine survival should be treated as deliberate experiments. Such practices include feeding regimes, net-pen rearing strategies, release times and release sites. As far as practical, the above factors should be varied in a controlled design so as not to confound the effects of different practices. Tagging data would greatly facilitate the evaluation of experimental

practices. For relatively simple comparisons (e.g., early vs late release timing), the use of fin-clips to evaluate terminal returns should not be disregarded in the absence of coded-wire-tags; fin-clips could provide a cost-effective evaluation tool. The cumulative cost of proceeding by trial and error will eventually far exceed the cost of starting with an appropriate experimental design.

3. Commercial fisheries managers should modify the fishing patterns in Northern Chatham Strait when weaknesses are detected in the northern inside pink salmon systems. If harvestable surpluses of stocks bound for southern areas exist during years of weak returns to northern areas, the northern boundary of the fishery in Chatham Strait should be moved to 58°01'45"north latitude, approximately two miles south of Point Marsden. Fishing could be conducted from there south. This boundary change should help improve escapements to both wild and hatchery systems in years of poor survival.

4. DIPAC, in cooperation with the department, should prepare a management plan for brood stock and economic escapement to its hatcheries for consideration by the Board of Fisheries.

5. Remote release sites for pink salmon cost recovery should be located and tested to determine if higher survivals can be attained outside Gastineau Channel. One potential site that should be considered is Barlow Cove.

6. Experimentation with early or late-run pink salmon brood stocks, which may return with higher survival rates, is encouraged. Earlier brood stock would be available from the Kadashan River, in Tenakee Inlet, or from the King Salmon River in upper Seymour Canal. Late-run pinks might be available from Auke Creek or from Homeshore Creek near Excursion Inlet. DIPAC should also consider other characteristics of potential donor stocks in addition to run-timing. Regardless of which run-timing is selected, in order to maintain a better distribution of spawning escapement, harvesting should allow some escapement from all portions of the run for brood stock.

7. In concert with the examination of new release sites and modification of run timing, DIPAC should explore the possibility of increasing production of pink salmon from its facilities to increase the likelihood of meeting its brood stock and cost-recovery goals. However, increasing production will not overcome problems with low marine survival and may even compound them. Factors causing low survival should be identified and rectified before increases in production are considered.

8. Tagging should be conducted to answer the question of how many DIPAC hatchery pink salmon are contributing to the commercial fisheries. Determination of hatchery return timing through the fishing areas, and an indication of the magnitude of its contribution would help fisheries managers design and implement inseason management programs to achieve optimal harvest rates.

Table 1. Commercial salmon harvest, by species, in District 114 by purse seine gear, 1960 - 1989.

Year	Chinook	Sockeye	Coho	Pink	Chum	Total
1960	261	136796	27863	363391	176751	705062
1961	336	213619	52531	2913987	535784	3716257
1962	2389	136712	34583	258076	436526	868286
1963	2055	201535	109133	9016292	328398	9657413
1964	1477	204304	115666	4440497	366584	5128528
1965	3309	280730	152488	3168720	581094	4186341
1966	3404	216858	105996	1868375	1122699	3317332
1967	1461	160019	93347	1549756	627225	2431808
1968	2181	230741	131485	4192274	635273	5191954
1969	3409	231535	66410	2413330	199149	2913833
1970	1824	163061	61107	2080548	643974	2950514
1971	1683	89395	81047	1646526	494289	2312940
1972	3085	96502	88820	1177601	681107	2047115
1973	2726	130788	47743	921233	350179	1452669
1974	646	20577	6724	86042	99870	213859
1975	22	2365	549	24714	41488	69138
1976	10	21	1504	2565	51510	55610
1977	0	0	0	0	0	0
1978	0	0	0	0	0	0
1979	0	3	130	1	3584	3718
1980	35	1702	1950	36169	226135	265991
1981	314	11059	6803	735131	135888	889195
1982	6	234	5045	167264	4004	176553
1983	178	2421	4202	328934	36700	372435
1984	150	5270	4407	43926	127219	180972
1985	576	3638	4314	1051611	53115	1113254
1986	12	1475	552	14551	58336	74926
1987	132	3793	2241	541592	121321	669079
1988	94	1229	2147	81792	59843	145105
1989	39	5643	3015	518471	14552	541720
Average	1060	85068	40393	1321446	273753	1721720

Table 2. Commercial salmon harvest, by species, in District 112 by purse seine gear, 1960 -1989.

Year	Chinook	Sockeye	Coho	Pink	Chum[1]	Total
1960	87	12399	5774	103730	49363	171353
1961	350	45493	16423	1196711	347173	1606150
1962	651	11148	3795	38668	130936	185198
1963	645	24268	15914	1981206	130648	2152681
1964	1076	34225	35204	1563094	111082	1744681
1965	2385	48756	44188	948866	194322	1238517
1966	1005	28737	26464	1162287	587484	1805977
1967	437	15891	13878	532069	329104	891379
1968	700	41874	35860	2532342	207061	2817837
1969	493	29563	13844	790152	77745	911797
1970	850	49548	71370	2018297	501090	2641155
1971	635	18502	28135	843523	193555	1084350
1972	1766	33578	42889	1079704	487645	1645582
1973	1133	32101	3747	458118	112249	607348
1974	414	23540	7965	204590	152329	388838
1975	0	0	0	0	0	0
1976	0	0	0	0	0	0
1977	0	0	0	0	0	0
1978	55	1261	2913	604812	11119	620160
1979	84	1577	1219	341115	9674	353669
1980	32	1153	3554	286783	82498	374020
1981	281	17031	13327	808934	39436	879009
1982	1037	26387	62157	5892839	90787	6073207
1983	422	25940	22254	1876781	151827	2077224
1984	720	22269	17492	1133240	856024	2029745
1985	2554	37121	25825	6061468	614017	6740985
1986	1191	8386	8680	344025	606286	968568
1987	748	44810	11085	1766047	523002	2345692
1988	737	3856	11579	599192	348393	963757
1989	611	48427	22246	5388216	160108	5619608
Average	703	22928	18926	1351894	236832	1631283

[1] Includes Hidden Falls Hatchery contributions in terminal fisheries

Table 3. Commercial salmon harvest, by species, in Subdistrict 112-16 (Hawk Inlet) by purse seine gear, 1960 -1989.

Year	Chinook	Sockeye	Coho	Pink	Chum	Total
1960	64	7590	2494	42641	12879	65668
1961	150	23693	8841	443030	69312	545026
1962	256	5395	1647	12605	42524	62427
1963	3481	15386	7542	816694	57843	897813
1964	545	18287	20202	610076	33047	682157
1965	1467	35565	20709	248511	69284	375536
1966	332	10198	6216	210835	53042	280623
1967	153	11196	7774	196070	49711	264904
1968	429	26702	19972	1109096	73153	1229352
1969	229	19933	4684	275241	21040	321127
1970	439	34742	39134	855233	164085	1093633
1971	488	15434	17652	503728	94320	631622
1972	1417	24035	28973	327832	183160	565417
1973	1104	27454	3048	392906	87675	512187
1974	227	18287	3632	87805	39716	149667
1975	0	0	0	0	0	0
1976	0	0	0	0	0	0
1977	0	0	0	0	0	0
1978	0	0	0	0	0	0
1979	0	575	440	48897	1931	51843
1980	0	633	1410	71720	9040	82803
1981	174	14460	7843	563403	21837	607717
1982	247	10756	25806	2565846	19508	2622163
1983	186	11908	13144	669060	21998	716296
1984	161	15326	12624	771591	98510	898212
1985	414	30013	12171	3471608	82463	3596669
1986	2	4716	3359	154259	7844	170180
1987	108	39723	8002	1225523	93546	1366902
1988	13	303	1222	44570	2583	48691
1989	184	35550	13576	2645868	51323	2746501
Average	305	15260	9735	611757	48711	685767

Table 4. Commercial salmon harvest, by species, in Subdistrict 114-27 (Whitestone Shore) by purse seine gear, 1960 - 1989.

Year	Chinook	Sockeye	Coho	Pink	Chum	Total
1960	8	282	68	1544	1150	3052
1961	101	22399	4882	554275	85344	667001
1962	260	3777	1451	19072	39443	64003
1963	592	11165	7364	931967	50286	1001374
1964	575	12344	13556	338411	41728	406614
1965	927	10349	11468	166869	48824	238437
1966	348	8780	5287	177135	87608	279158
1967	196	4300	3709	116407	52762	177374
1968	64	5196	3454	264292	38996	312002
1969	524	8874	5563	475421	41196	531578
1970	112	5441	4372	298111	82682	390718
1971	350	3425	8327	307798	81415	401315
1972	998	5942	18748	230531	195968	452187
1973	505	7544	4380	211217	65860	289506
1974	198	1446	589	17046	6853	26132
1975	9	883	111	9971	3947	14921
1976	0	0	0	0	0	0
1977	0	0	0	0	0	0
1978	0	0	0	0	0	0
1979	0	0	0	0	0	0
1980	0	0	0	0	0	0
1981	306	10793	2729	698719	34247	746794
1982	6	234	5045	167264	4004	176553
1983	152	2336	3288	328144	25893	359813
1984	61	2900	328	9010	22266	34565
1985	323	2169	2874	694777	22200	722343
1986	7	1307	120	13098	4647	19179
1987	115	3122	1137	524771	26932	556077
1988	13	118	257	21290	20714	42392
1989	46	5690	2918	550416	14222	573292
Average	226	4687	3729	236518	36615	281776

Table 5. Opening dates and northern boundaries of the Hawk Inlet Shore (Subdistrict 112-16) from 1967 to 1989.

Year	Opening Date S. of Pt. Marsden		Boundary N. of Pt. Marsden
1967	July 11	July 11	Lat. of Little Is.
1968	June 30	June 30	Lat. of Little Is.
1969	July 6	July 6	Lat. of Little Is.
1970	July 5	July 5	Lat. of Little Is.
1971	July 18	July 18	Lat. of Pt. Couverden
1972	July 3	July 3	Lat. of Pt. Couverden
1973	July 8	Not Open	
1974	August 6	Not Open	
1975	Not Open	Not Open	
1976	Not Open	Not Open	
1977	Not Open	Not Open	
1978	Not Open	Not Open	
1979	August 5	August 5	Lat. of Hanus Reef
1980	August 10	August 10	Lat. of Hanus Reef
1981	July 12	July 12	58 10' 00" N. Lat.
1982	August 1	August 1	Lat. of Hanus Reef
1983	July 24	July 24	Lat. of Hanus Reef
1984	July 22	August 2	Lat. of Hanus Reef
1985	July 18	August 1	Lat. of Hanus Reef
1986	August 7	Not Open	
1987	July 12	August 2	Lat. of Hanus Reef
1988	August 7	Not Open	
1989	July 20	July 9	58 13' 39" N. Lat.

Table 6. Subdistrict 112-16 preliminary salmon harvest by week, 1989.

Stat. Week	Days Open	Kings	Reds	Coho	Pink	Chum	Boats	Boat/Days
28 7/9	1	28	3,200	170	92,671	5,415	63	63
29 7/16-17	2	123	11,477	1,021	557,172	13,402	45	90
29 7/20 7/23-24	1	0	1,824	238	254,077	3,803	40	40
30 7/27-28	4	1	7,879	1,486	669,595	15,312	42	168
31 7/31-8/1 8/4-5	4	12	5,728	981	314,112	2,794	32	128
32 8/6,9-11	4	9	2,885	3,153	365,940	5,832	18	72
33 8/14-17	4	0	974	1,386	152,233	1,094	10	40
34 8/20-22	3	2	1,470	3,621	188,913	2,432	10	30
35 8/27-30	4	9	113	1,520	51,155	1,239	10	40
Total harvest N. of Pt. Marsden during July	3	151	14,677	1,191	649,843	18,817	154	
Total harvest after July fishery N. of Pt. Marsden	24	33	20,873	12,385	1,996,025	32,506	518	
TOTAL	27	184	35,550	13,576	2,645,868	51,323	672	

Table 7. Preliminary Commercial Pink Salmon Landings in Subdistricts 114-27 and 112-16, and DIPAC Cost Recovery Harvests during July, 1985, 1987 and 1989.

	Year/Area								
July Date	114-27	112-16	SHA	114-27	112-16	SHA	114-27	112-16	SHA
1									
2									
3									
4									
5				481,759					
6									186
7									276
8						10,000			1,392
9							33,425	92,671	2,017
10									1,299
11									143
12					200,565	23,344			2,556
13									2,155
14			40,828						1,926
15						21,092			2,812
16						63,968		156,054	
17								401,118	2,599
18	125,339	203,452				26,333			3,239
19			45,653		287,937	52,252			166
20						26,219	39,082	254,077	96
21	59,393	88,398				39,046			670
22	277,831	251,051	82,100			22,088			
23					184,719	16,367	79,997	123,565	
24							204,103	173,987	
25		277,522	32,950			63,066			
26			2,890		187,370				
27			8,496		144,813	27,463	88,098	144,858	
28		138,277				40,563	105,711	227,185	
29		238,217	13,066			19,954			
30			9,771			29,489			
31			18,460					71,893	
Total	462,563	1,196,917	254,214	481,759	1,005,404	481,244	550,416	1,645,408	21,532

Table 8. Subdistrict 112-16 (Hawk Inlet Shore) summary of harvest and effort, 1982-1989.

YEAR	BT/DAYS EFFORT	PEAK BTS	DAYS OPEN	N.LINE* DAYS	CATCH (1,000'S) REDS	COHO	PINK	CHUM
1982	1054	95	17	H/15 M/2	10.8	25.8	2,565.8	19.5
1983	312	28	23	H/13 M/10	11.9	13.1	669.1	22.0
1984	510	72	15	H/5 M/10	15.3	12.6	771.6	98.5
1985	1061	82	22	H/13 M/9	30.0	12.2	3,471.6	82.5
1986	54	11	6	M/6	4.7	3.4	154.3	7.8
1987	653	103	10	H/4 M/6	39.7	8.0	1,225.5	93.5
1988	30	15	2	M/2	0.3	1.2	44.6	2.6
1989	672	64	27	F/3 H/1 M/23	35.6	13.6	2,664.2	51.3

* NORTHERN LINE CODE F=FUNTER, H=HANUS, M=MARSDEN

Table 9. Snettisham Hatchery chum salmon returns and estimates of fisheries contribution, 1984-1989.

	TAG EXPANSION ESTIMATES HARVEST						FISHERY PERFORMANCE ESTIMATES HARVEST			
YEAR	RACK	STRAYS	GILLNET	SEINE	TOTAL	RATE	GILLNET	SEINE	TOTAL	RATE
1984	4,852	4,852	6,718	182	16,604	41.6%	15,000	400	25,104	61.3%
1985	24,436	13,687	24,251	3,241	65,615	41.9%	52,000	7,000	97,123	60.7%
1986	26,686	12,314	13,500	1,800	54,300	28.2%	16,000	2,000	57,000	31.6%
1987	50,250	12,500	12,037	1,456	76,243	17.7%	35,000	4,000	101,750	38.3%
1988	9,000	3,000	19,000	0	31,000	61.3%	48,000		60,000	80.0%
1989	3,000	500	0	0	3,500	0.0%	2,000		5,500	36.4%

Table 10. Total northbound sockeye salmon known to be present in Upper Chatham Strait in 1989 and estimated harvest rate in Subdistrict 112-16.

Area	Sockeye Salmon
District 15 Catch	471,934
Chilkoot Escapement	54,900
Chilkat Escapement	141,000
District 11 Catch	74,019
Taku River Escapement	94,000
Taku Canadian Catch	18,598
Speel R. Escapement	12,229
Crescent R. Escapement	1,099
Total Sockeye	867,779
Subdistrict 112-16 Catch	35,905

Harvest Rate assuming all harvested sockeye were northbound stocks = 4.1%

Table 11. Survival model for DIPAC pink salmon in 1985.

	DIPAC HATCHERIES			
FRY RELEASED	32010000			
HATCHERY CATCH	263214			
HATCHERY EGGTAKE	38318			
OTHER	73500			
TOTAL RETURN	375032			
		COMMERCIAL CATCH OF MIXED STOCKS		
PURSE SEINE IN 112-16	3471600			
PURSE SEINE IN 114-27	846700			
GILLNET IN 111	311200			
TOTAL CATCH	4629500			
POSSIBLE MARINE SURVIVAL PERCENTS	TOTAL DIPAC RETURN	TOTAL CATCH OF DIPAC FISH	% HARVEST RATE ON DIPAC FISH	% CONTRIBUTION OF DIPAC FISH TO COMMERCIAL CATCH
0.2	64020	-311012	-485.8	-6.7
0.4	128040	-246992	-192.9	-5.3
0.6	192060	-182972	-95.3	-4.0
0.8	256080	-118952	-46.5	-2.6
1.0	320100	-54932	-17.2	-1.2
1.2	384120	9088	2.4	0.2
1.4	448140	73108	16.3	1.6
1.6	512160	137128	26.8	3.0
1.8	576180	201148	34.9	4.3
2.0	640200	265168	41.4	5.7
2.2	704220	329188	46.7	7.1
2.4	768240	393208	51.2	8.5
2.6	832260	457228	54.9	9.9
2.8	896280	521248	58.2	11.3
3.0	960300	585268	60.9	12.6
3.2	1024320	649288	63.4	14.0
3.4	1088340	713308	65.5	15.4
3.6	1152360	777328	67.5	16.8
3.8	1216380	841348	69.2	18.2
4.0	1280400	905368	70.7	19.6
4.2	1344420	969388	72.1	20.9
4.4	1408440	1033408	73.4	22.3
4.6	1472460	1097428	74.5	23.7
4.8	1536480	1161448	75.6	25.1
5.0	1600500	1225468	76.6	26.5
5.2	1664520	1289488	77.5	27.9
5.4	1728540	1353508	78.3	29.2
5.6	1792560	1417528	79.1	30.6
5.8	1856580	1481548	79.8	32.0
6.0	1920600	1545568	80.5	33.4

Table 12. Survival model for DIPAC pink salmon in 1987.

	DIPAC HATCHERIES			
FRY RELEASED	35820000			
HATCHERY CATCH	485459			
HATCHERY EGGTAKE	41423			
OTHER	1200			
TOTAL RETURN	528082			
	COMMERCIAL CATCH OF MIXED STOCKS			
PURSE SEINE IN 112-16	1225500			
PURSE SEINE IN 114-27	481800			
GILLNET IN 111	355700			
TOTAL CATCH	2063000			
POSSIBLE MARINE SURVIVAL PERCENTS	TOTAL DIPAC RETURN	TOTAL CATCH OF DIPAC FISH	% HARVEST RATE ON DIPAC FISH	% CONTRIBUTION OF DIPAC FISH TO COMMERCIAL CATCH
0.2	71640	-456442	-637.1	-22.1
0.4	143280	-384802	-268.6	-18.7
0.6	214920	-313162	-145.7	-15.2
0.8	286560	-241522	-84.3	-11.7
1.0	358200	-169882	-47.4	-8.2
1.2	429840	-98242	-22.9	-4.8
1.4	501480	-26602	-5.3	-1.3
1.6	573120	45038	7.9	2.2
1.8	644760	116678	18.1	5.7
2.0	716400	188318	26.3	9.1
2.2	788040	259958	33.0	12.6
2.4	859680	331598	38.6	16.1
2.6	931320	403238	43.3	19.5
2.8	1002960	474878	47.3	23.0
3.0	1074600	546518	50.9	26.5
3.2	1146240	618158	53.9	30.0
3.4	1217880	689798	56.6	33.4
3.6	1289520	761438	59.0	36.9
3.8	1361160	833078	61.2	40.4
4.0	1432800	904718	63.1	43.9
4.2	1504440	976358	64.9	47.3
4.4	1576080	1047998	66.5	50.8
4.6	1647720	1119638	68.0	54.3
4.8	1719360	1191278	69.3	57.7
5.0	1791000	1262918	70.5	61.2
5.2	1862640	1334558	71.6	64.7
5.4	1934280	1406198	72.7	68.2
5.6	2005920	1477838	73.7	71.6
5.8	2077560	1549478	74.6	75.1
6.0	2149200	1621118	75.4	78.6

Table 13. Survival model for DIPAC pink salmon in 1989.

	DIPAC HATCHERIES			
FRY RELEASED	41600000			
HATCHERY CATCH	24353			
HATCHERY EGGTAKE	42232			
OTHER	15526			
TOTAL RETURN	82111			
		COMMERCIAL CATCH OF MIXED STOCKS		
PURSE SEINE IN 112-16	2604300			
PURSE SEINE IN 114-27	517000			
GILLNET IN 111	180600			
TOTAL CATCH	3301900			
POSSIBLE MARINE SURVIVAL PERCENTS	TOTAL DIPAC RETURN	TOTAL CATCH OF DIPAC FISH	% HARVEST RATE ON DIPAC FISH	% CONTRIBUTION OF DIPAC FISH TO COMMERCIAL CATCH
0.2	83200	1089	1.3	0.0
0.4	166400	84289	50.7	2.6
0.6	249600	167489	67.1	5.1
0.8	332800	250689	75.3	7.6
1.0	416000	333889	80.3	10.1
1.2	499200	417089	83.6	12.6
1.4	582400	500289	85.9	15.2
1.6	665600	583489	87.7	17.7
1.8	748800	666689	89.0	20.2
2.0	832000	749889	90.1	22.7
2.2	915200	833089	91.0	25.2
2.4	998400	916289	91.8	27.8
2.6	1081600	999489	92.4	30.3
2.8	1164800	1082689	93.0	32.8
3.0	1248000	1165889	93.4	35.3
3.2	1331200	1249089	93.8	37.8
3.4	1414400	1332289	94.2	40.3
3.6	1497600	1415489	94.5	42.9
3.8	1580800	1498689	94.8	45.4
4.0	1664000	1581889	95.1	47.9
4.2	1747200	1665089	95.3	50.4
4.4	1830400	1748289	95.5	52.9
4.6	1913600	1831489	95.7	55.5
4.8	1996800	1914689	95.9	58.0
5.0	2080000	1997889	96.1	60.5
5.2	2163200	2081089	96.2	63.0
5.4	2246400	2164289	96.3	65.5
5.6	2329600	2247489	96.5	68.1
5.8	2412800	2330689	96.6	70.6
6.0	2496000	2413889	96.7	73.1

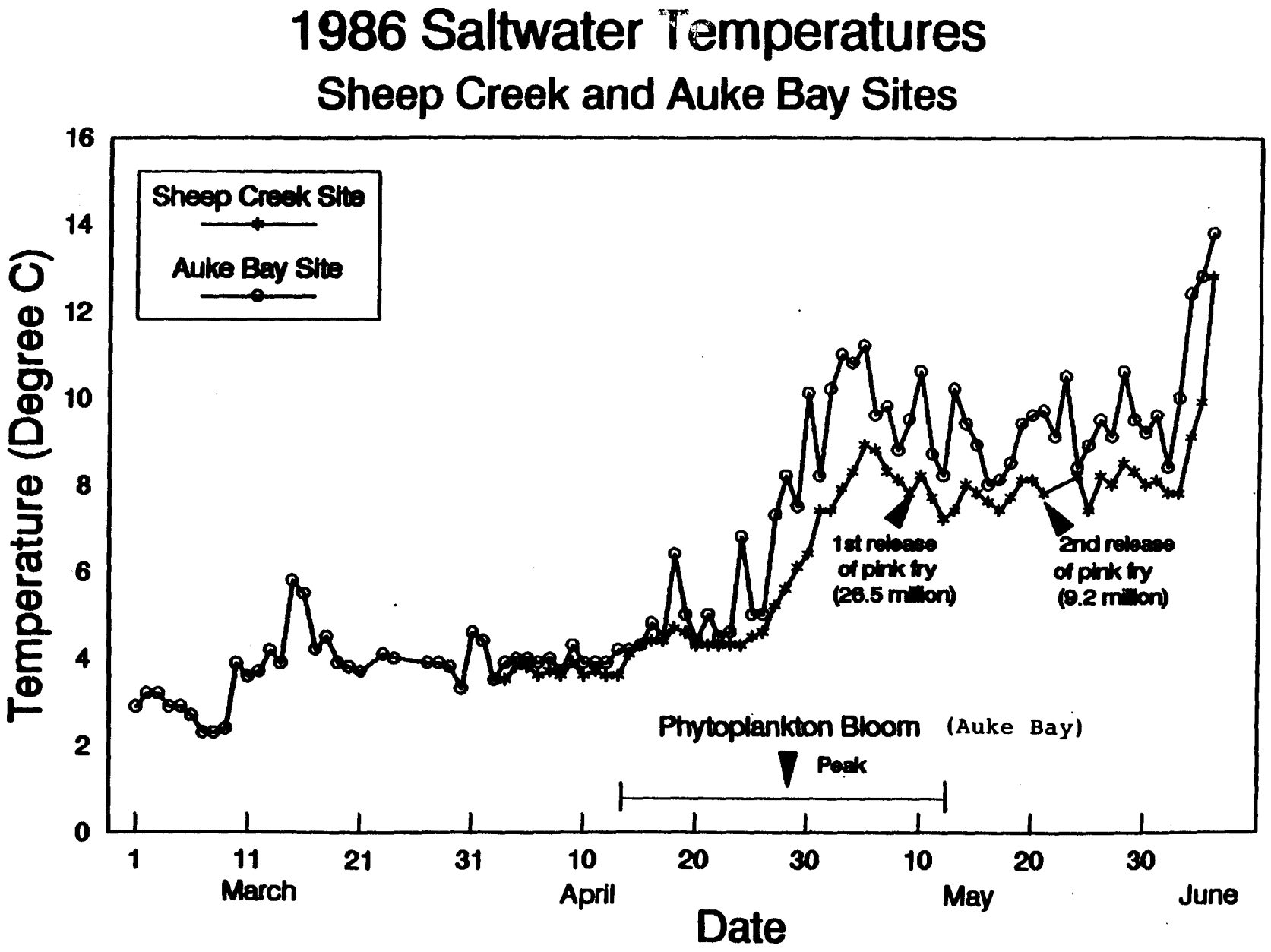


Figure 1. Saltwater temperatures at Sheep Creek and Auke Bay sites in 1986.

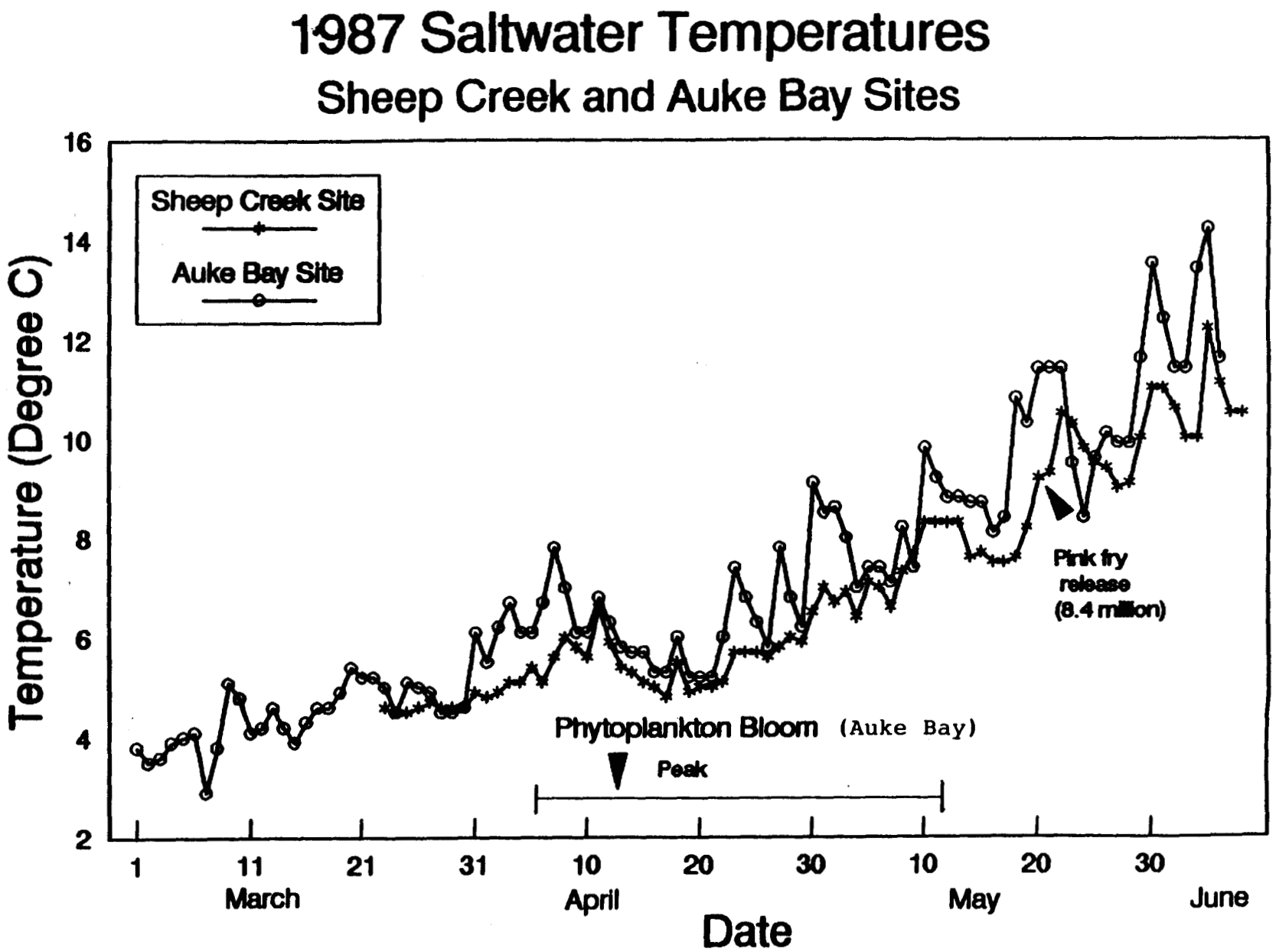


Figure 2. Saltwater temperatures at Sheep Creek and Auke Bay sites in 1987.

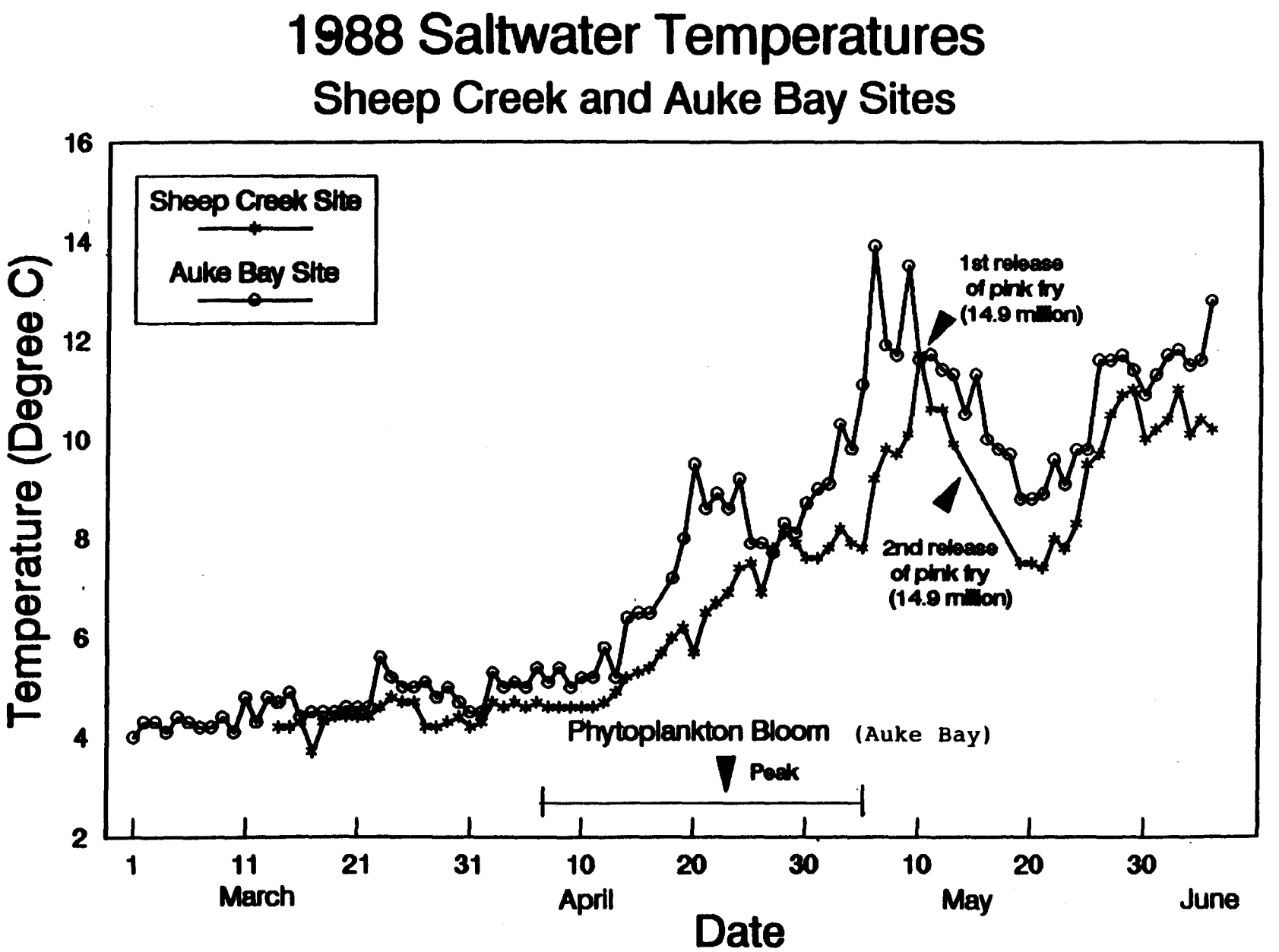


Figure 3. Saltwater temperatures at Sheep Creek and Auke Bay sites in 1988.

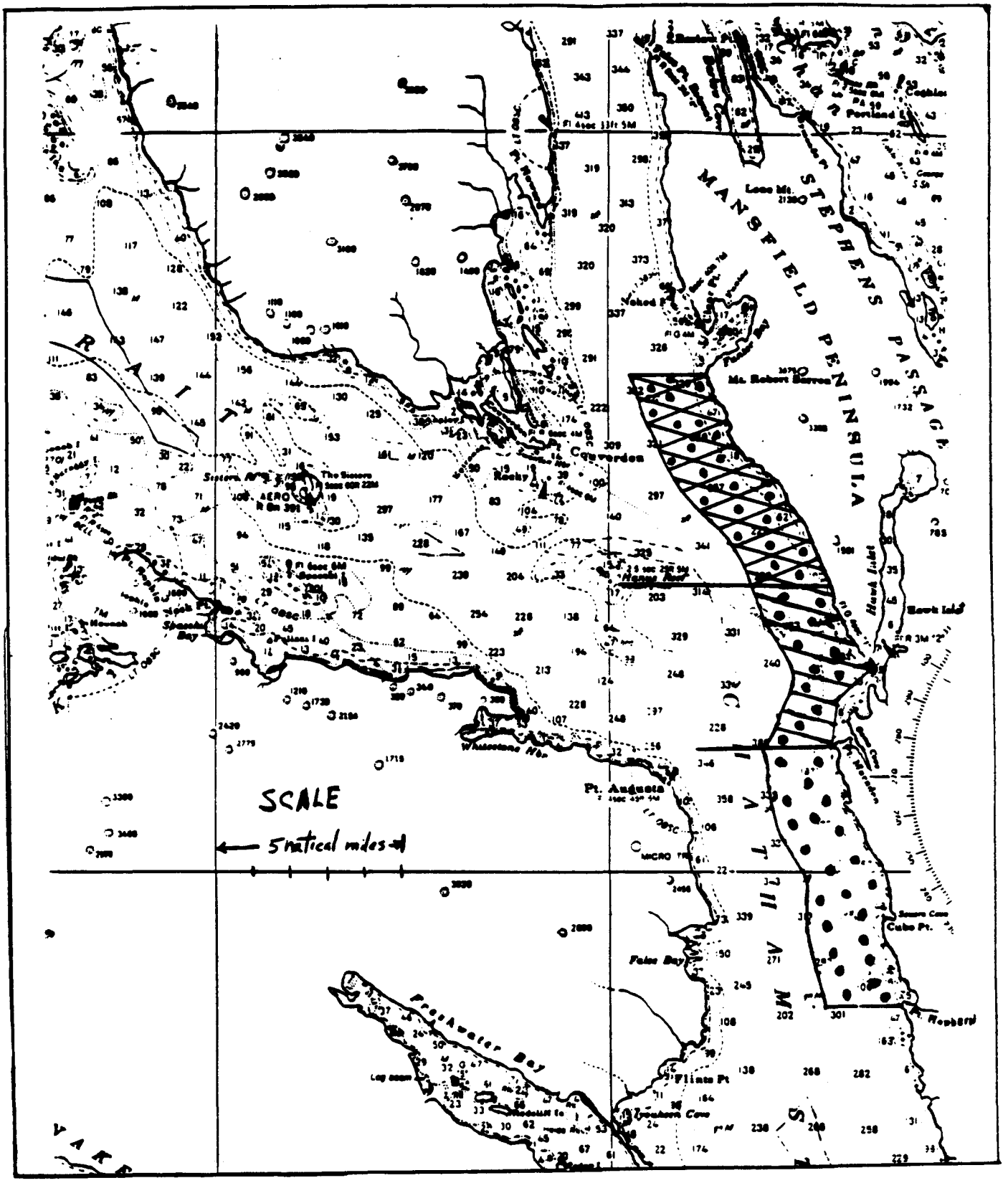


Figure 4. Expanded view of Hawk Inlet Shore, Subdistrict 112-16, with July 9 and 16th-17th, fishing areas.

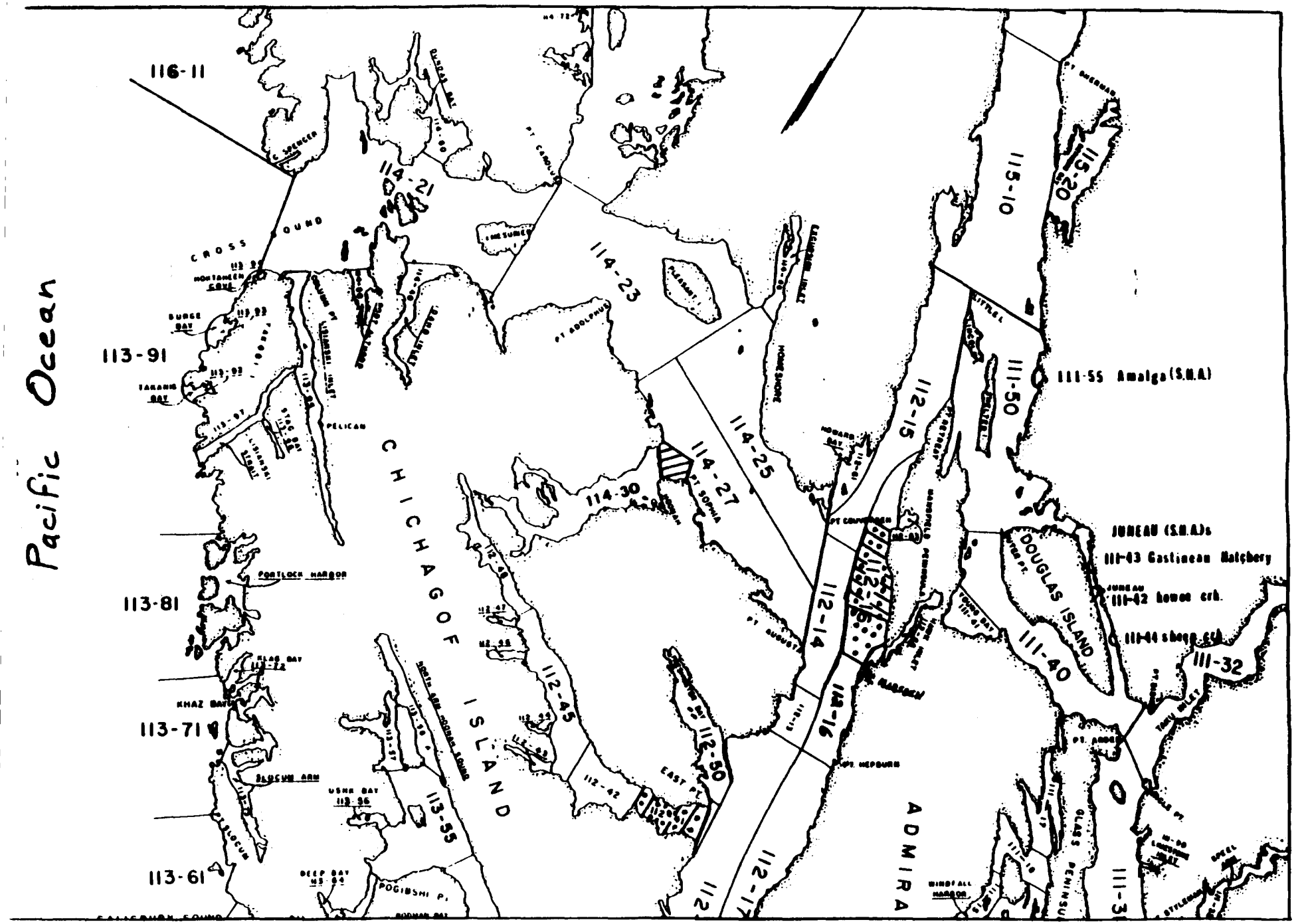


Figure 5. Northern Chatham Strait Purse Seine fishing areas open on July 9 ▨ and July 16-17 ▨.

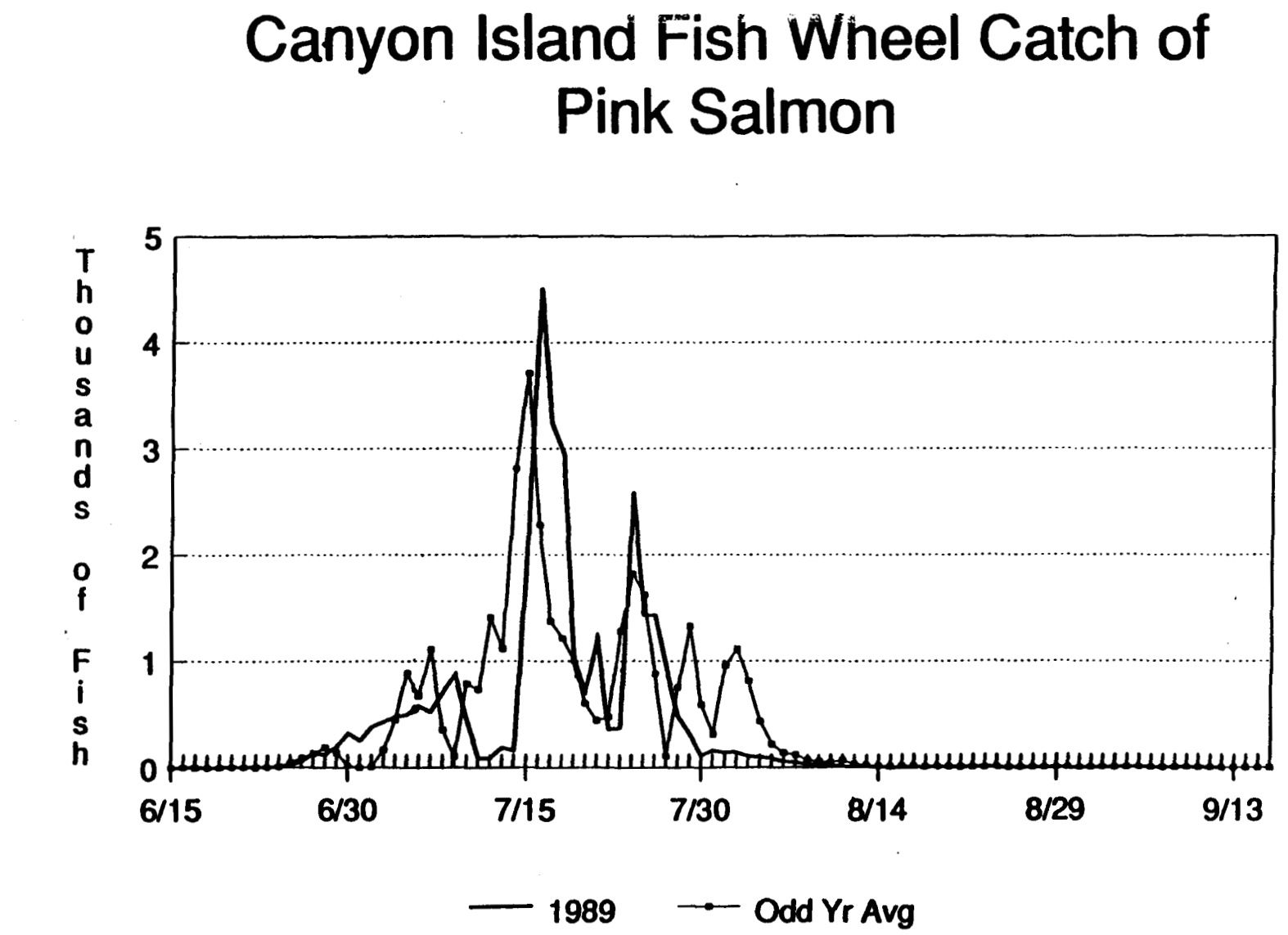


Figure 6. Canyon Island fish wheel catch of pink salmon, 1989.

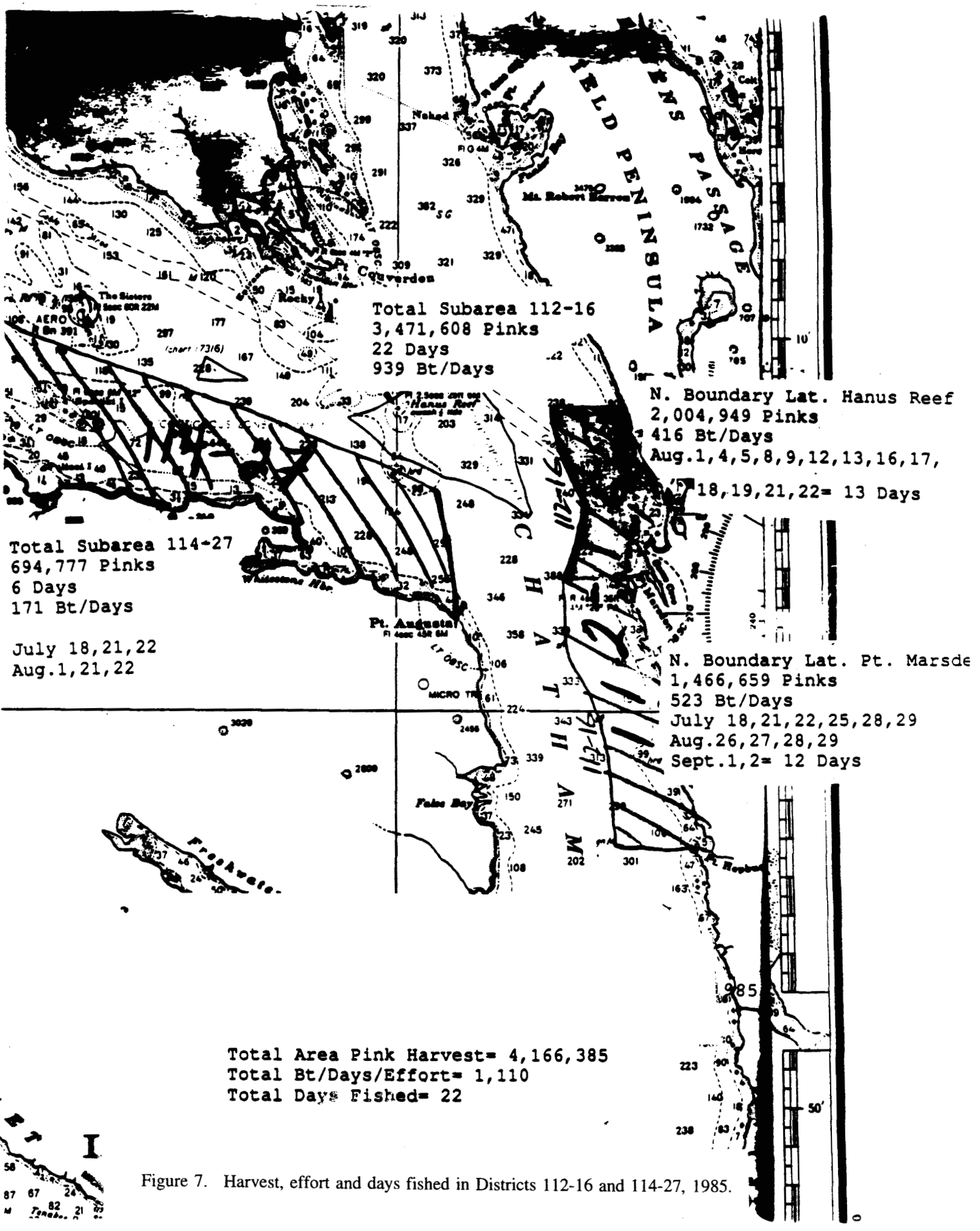


Figure 7. Harvest, effort and days fished in Districts 112-16 and 114-27, 1985.

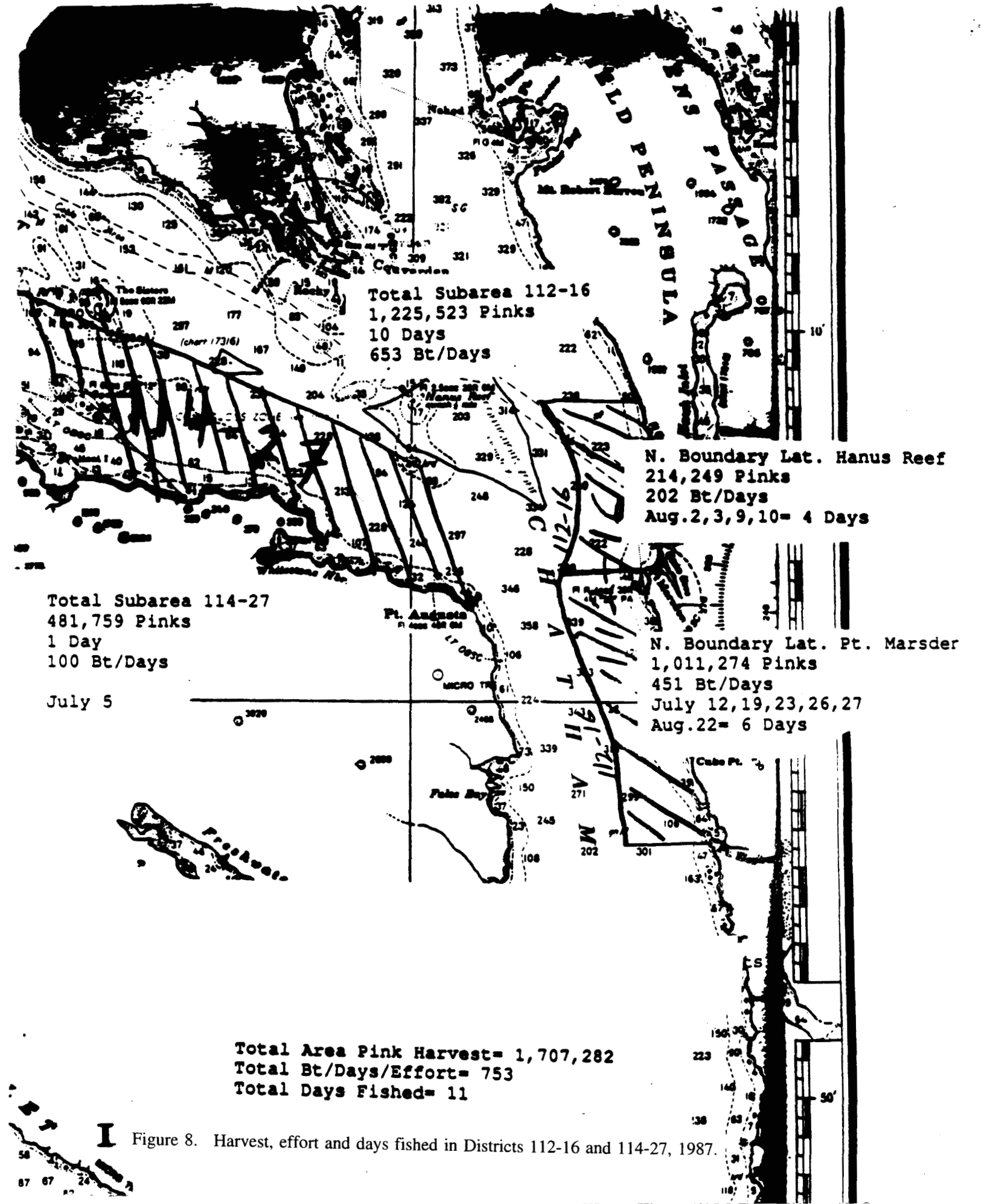


Figure 8. Harvest, effort and days fished in Districts 112-16 and 114-27, 1987.

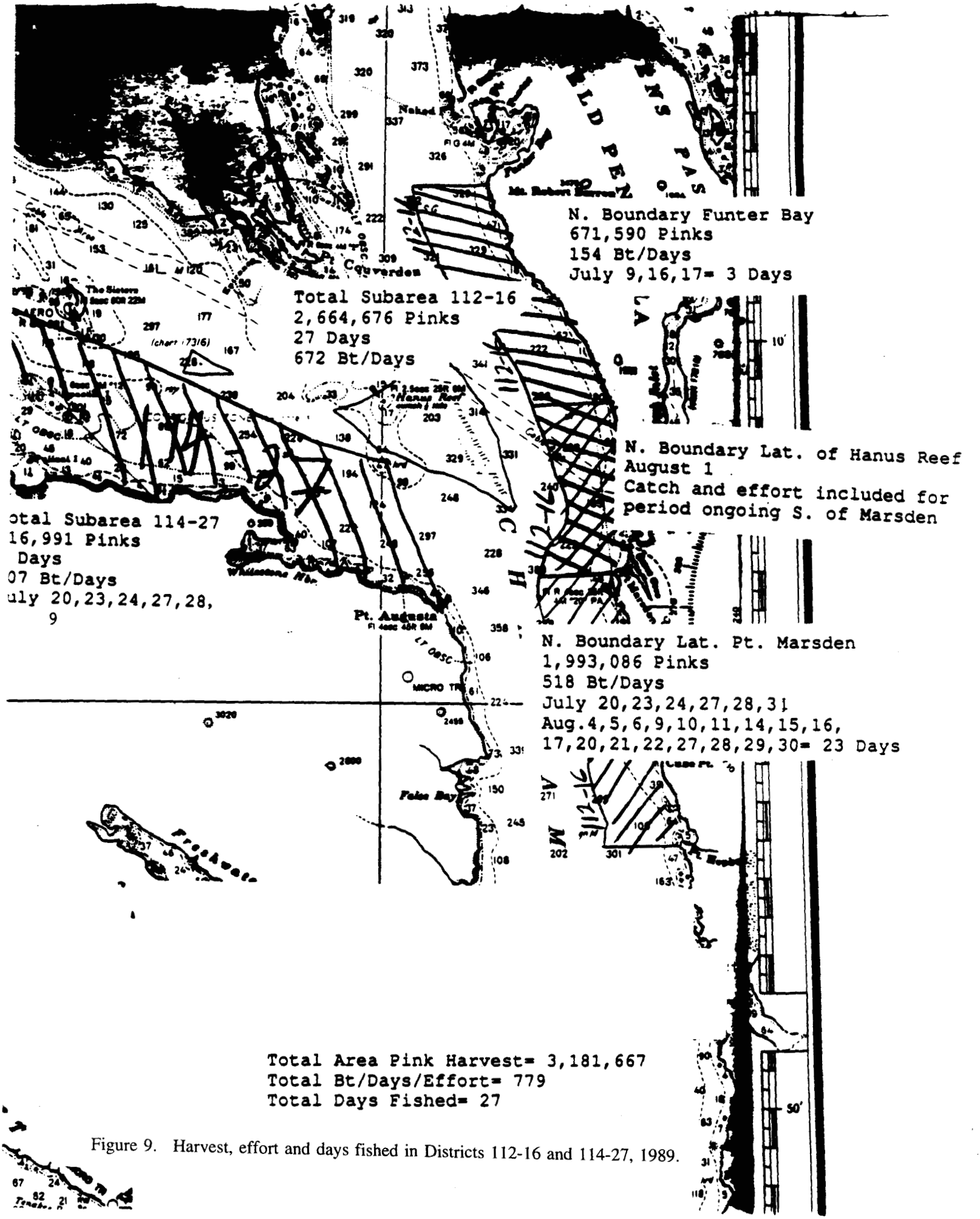


Figure 9. Harvest, effort and days fished in Districts 112-16 and 114-27, 1989.

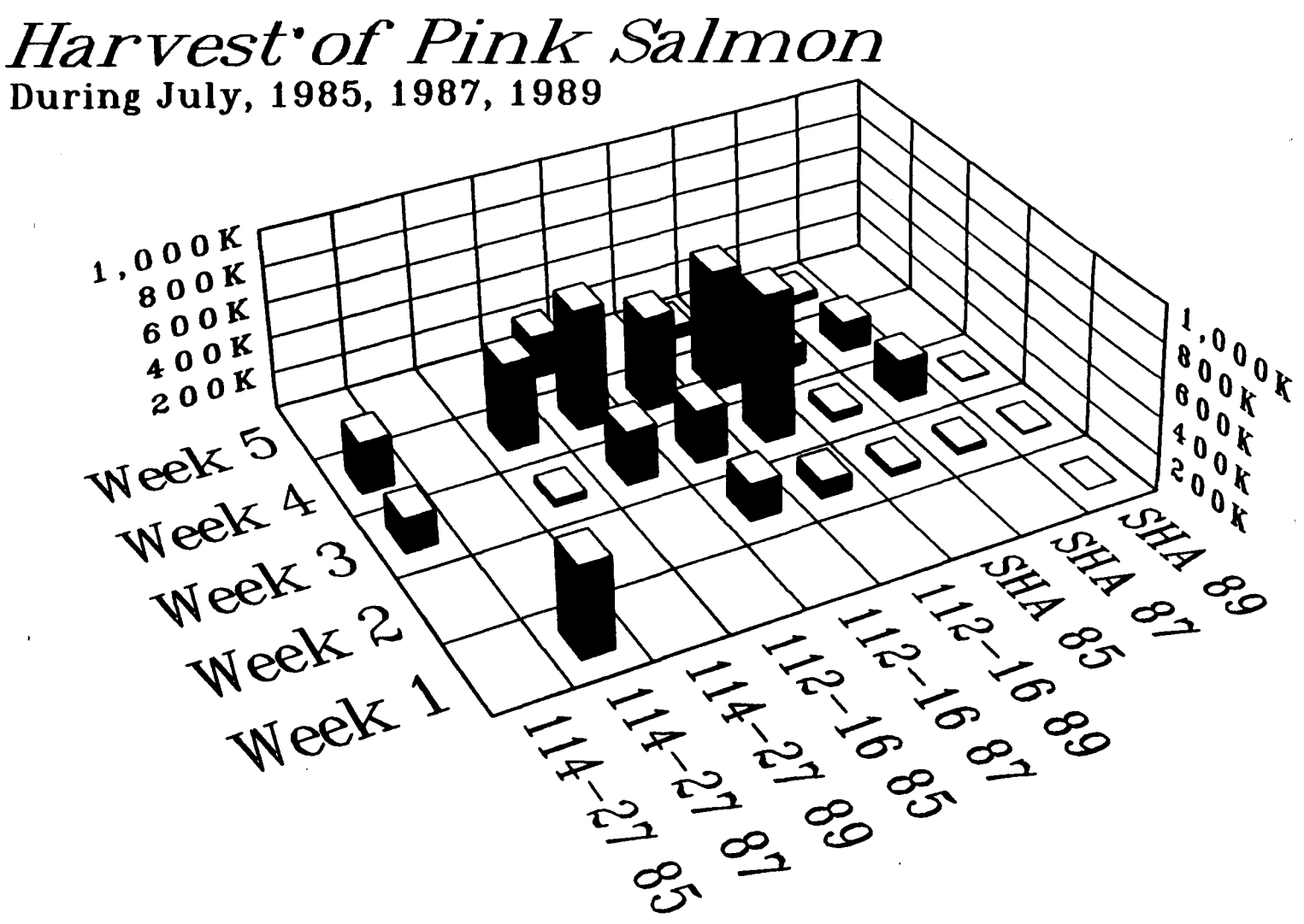


Figure 10. Harvest of pink salmon by calendar week for Subdistricts 112-16, 114-27, and the DIPAC special harvest area, 1985, 1987 and 1989.

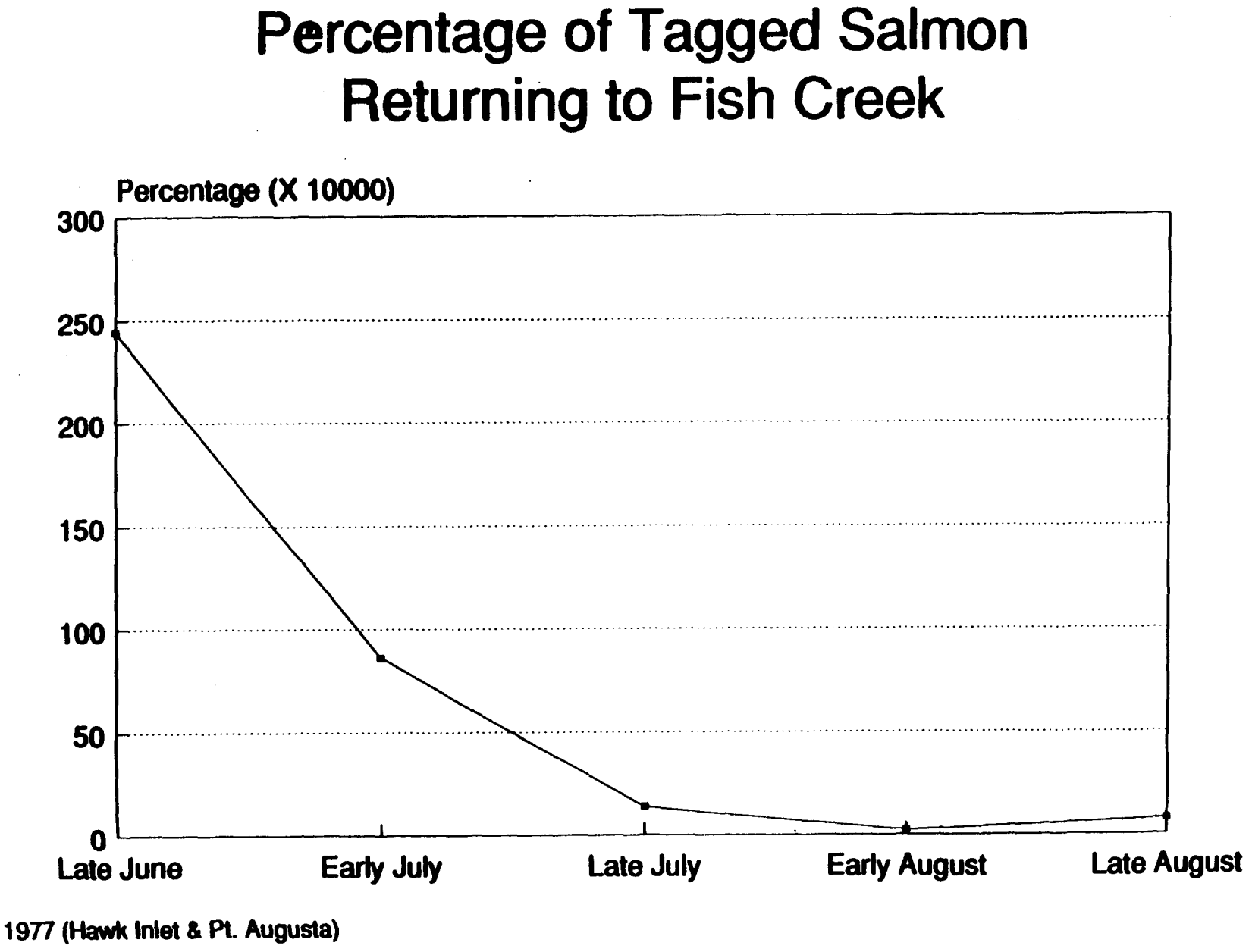


Figure 11. Percentage of adult pink salmon returning to Fish Creek in 1989 that were tagged in the area of Hawk Inlet and Point Augusta in 1977.

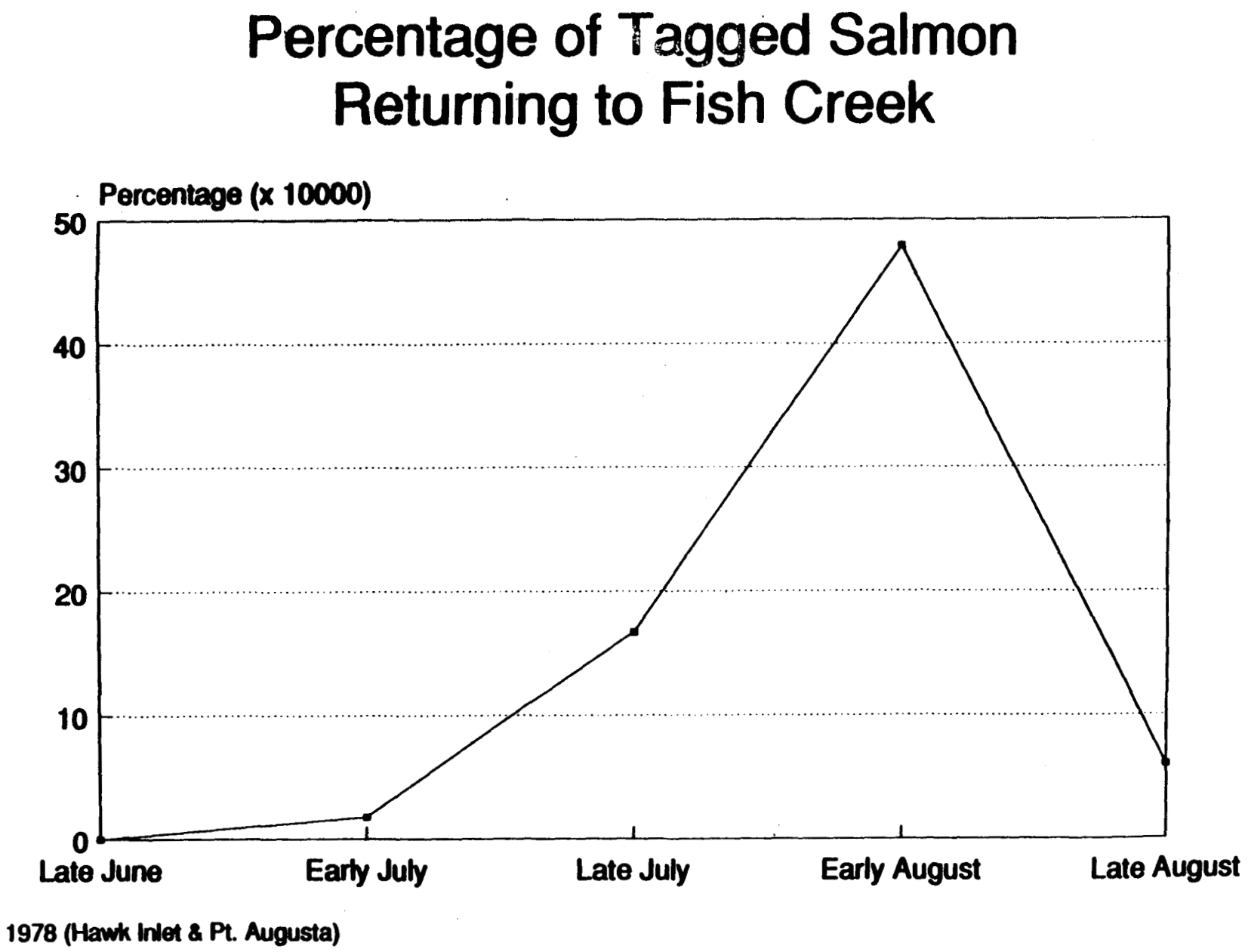


Figure 12. Percentage of adult pink salmon returning to Fish Creek that were tagged in the area of Hawk Inlet and Point Augusta in 1978.

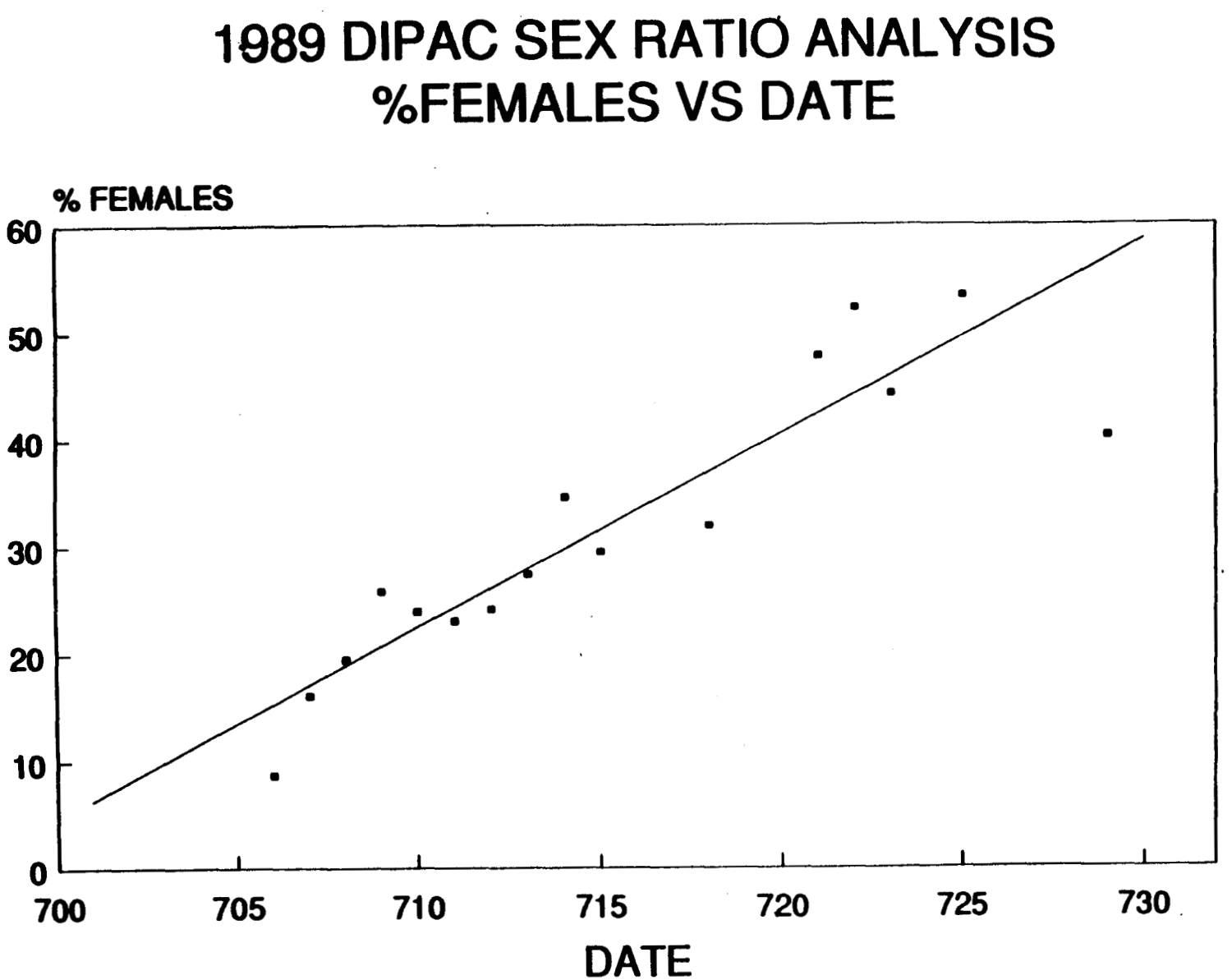


Figure 13. Sex ratio of pink salmon harvested by DIPAC in the Sheep Creek special harvest area in 1989.

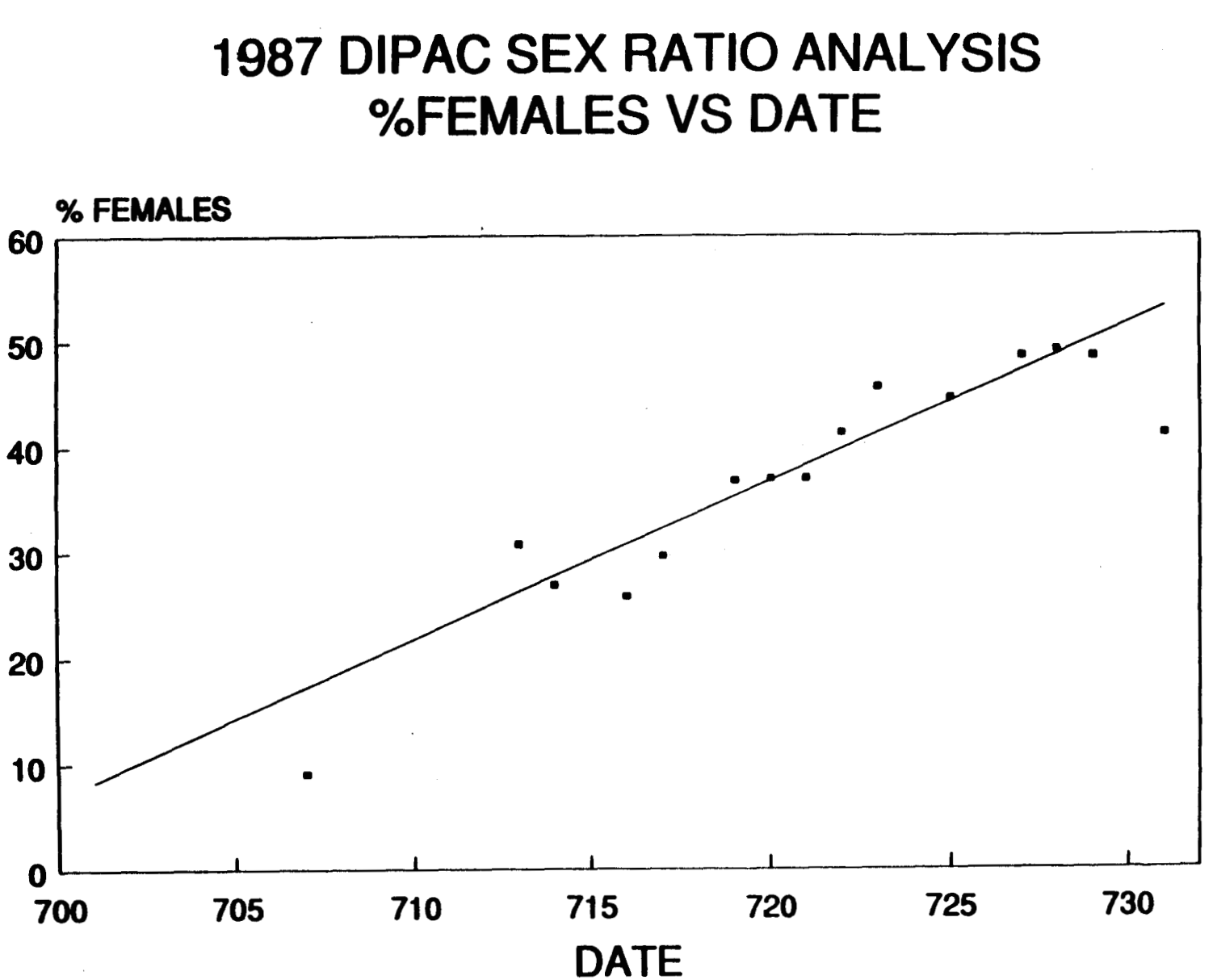


Figure 14. Sex ratio of pink salmon harvested by DIPAC in the Sheep Creek special harvest area in 1987.

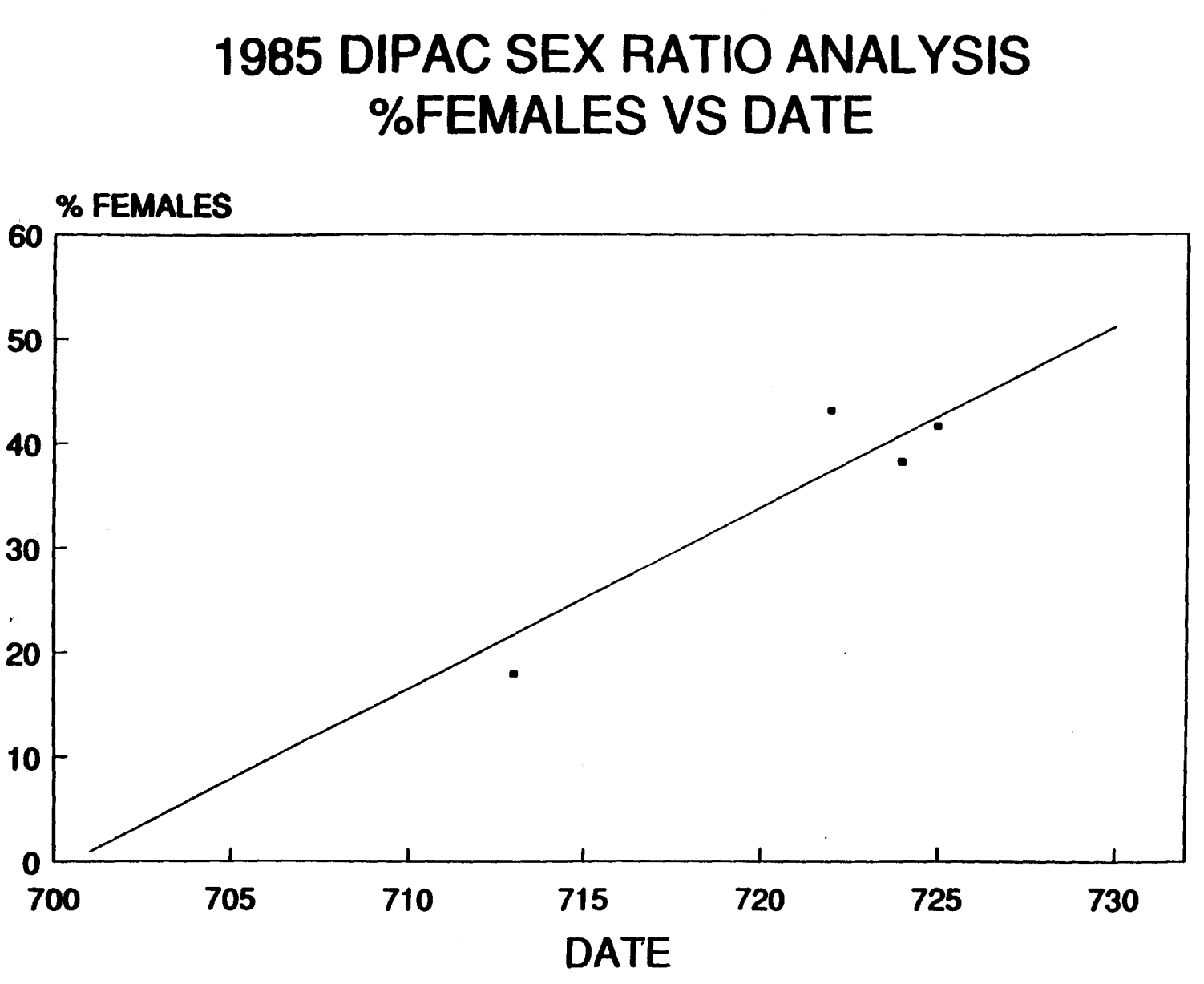
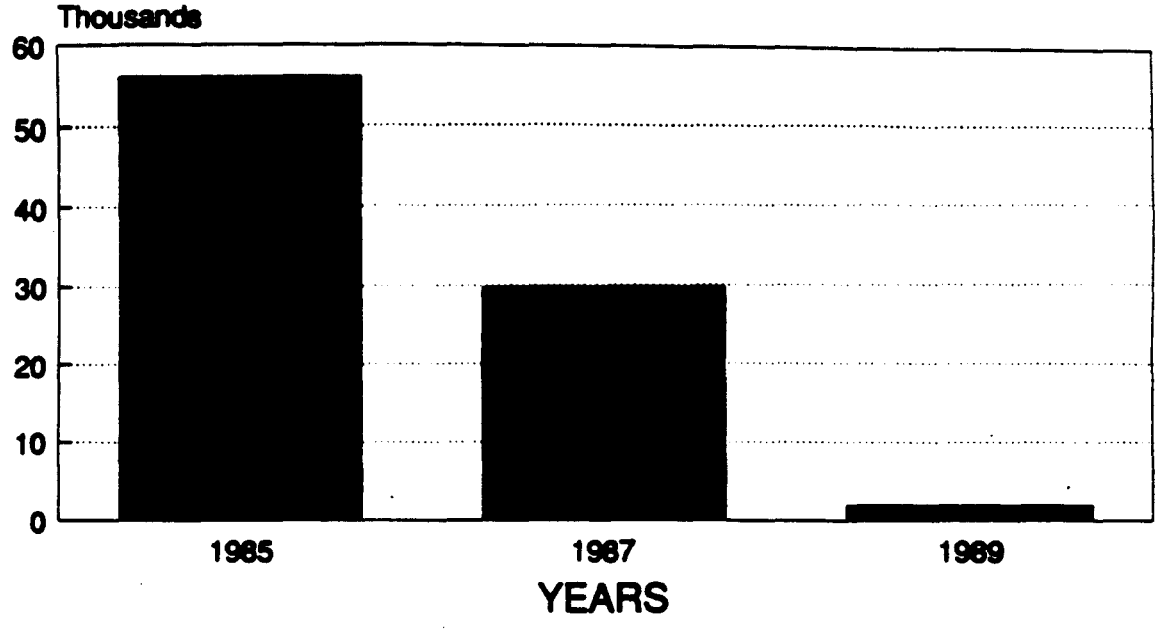


Figure 15. Sex ratio of pink salmon harvested by DIPAC in the Sheep Creek special harvest area in 1985.



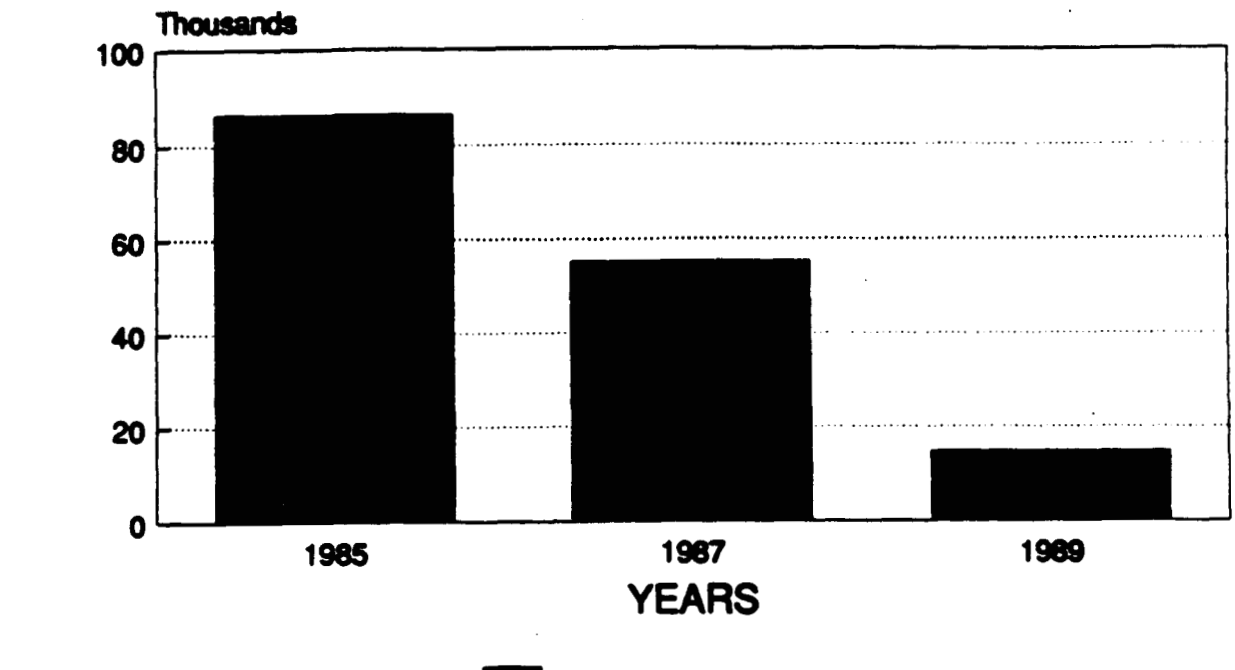
Cum CPUE	56046	29724	1950

DIPAC HATCHERY HARVEST

CATCH IN 112-16 UP TO JULY 15

	1985	1987	1989
Date	--	7/12	7/9
Catch	0	200000	110000
# of Boats	0	81	62

Figure 16. Cumulative catch per unit of effort for pink salmon harvested by DIPAC in the Sheep Creek special harvest area up to July 15, and the commercial catch in Subdistrict 112-16, 1985, 1987 and 1989.



Catch	86481	55246	14762
Sets	4	11	69

DIPAC HATCHERY HARVEST

Figure 17. Cumulative catch up to July 15 in the Sheep Creek special harvest area, 1985, 1987 and 1989.